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JUNE, 1930, TO MARCH, 1931

(Complete in ten numbers)

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UNIVERSITY OF THE PHILIPPINES

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ERRATA

Page 4, line 2 from bottom "20 days" should read "28 days".

Page 32, line 12 from botton "Philippines fungus" should read "Philippine fungus".

Page 42, after line 10 from bottom add "Ocfemia, G. O., and M. A. Palo. 1926. The relation of certain Philippine commercial varieties of bananas to the wilt disease due to *Fusarium cubense* EFS. The Philippine Agriculturist **15:** 243–244."

Page 79, lines 11 and 15 "pokkah-bong" should read "pokkah-boeng."

Page 220, line 8 from top "$E=0.052+0.075$ pH" should read "$E=0.052+0.057$ pH."

Page 269, line 6 from bottom "reaction of G 9-2 sugars" should read "reaction of G 9-2 to sugars".

Page 283, line 4 from bottom "bank officiales" should read "bank officials".

Page 307, lines 2 and 3 from bottom "Thesis presented for graduation, 1930, from the College of Agriculture, No. 675; Experiment Station contribution No. 318" should read "Thesis presented for graduation, 1930, from the College of Agriculture, No. 318; Experiment Station contribution No. 675."

Page 653, line 20 from bottom "Dr. B. M. Livingston" should read "Dr. B. E. Livingston."

Page 658, line 16 from bottom "older climate" should read "colder climate".

Page 663, line 7 from top "5.38 per cent" should read "5.36 per cent."

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PROFESSIONAL EDUCATION IN THE PHILIPPINES[1]

The Manila press, apparently alarmed, in recent issues carried in glaring head lines the statement that out of two hundred and sixty-eight teachers recently graduated from the College of Education of the State University, only fifteen can be appointed in the city schools, as that number would fill the vacancies, but that if the graduates sought work in provinces some of them would find berths. About two decades ago a similar story was printed about law graduates, only in this case they numbered over a thousand, and the same advice was given. Not so many years ago the graduates of the Nautical School advocated the closing of their Alma Mater until such time as graduates could find employment. And dental schools, pharmacy schools, engineering schools, schools of arts and trades, and other schools have had to face the same bugaboo in the last decade or two.

A young country, as is the Philippines, which remained backward for long, had to make up in some way for its lengthy period of lethargy and it is finding in organized education through schools the quickest way of keeping abreast of the world, in appearance at least, if not in substance.

Sufficient time has elapsed since the first alarm was sounded that certain professions have become overcrowded and we may well look back as to what has happened to remedy the situation. In the first place, wherever there was a demand, so called professional schools sprouted up like mushrooms. Many of these died a natural death, while following the natural law of survival of the fittest a few still live. Students no longer flock to the schools of crowded professions with the single goal of finding a job upon graduation, but rather select their courses after first taking stock of aptitude and then applying more and more the sound criterion of whether their aptitude bears capitalizing in a particular profession. The natural result is that we have developed and are developing a better class of professionals and the "horror" of all wanting to remain in the city has ceased to be.

Agricultural education being relatively unknown in the Philippines before American occupation, upon its inception it was not even considered by the public as on a level with other learned professions. Therefore enrollment in the only College of Agriculture of university grade in the Philippines was to a large extent confined to not only those who felt a desire to make agriculture their vocation, but also to those who had to overcome the prejudices of their parents and relatives and face a lowering in the estimate of the public. Private enterprise saw little prospect of financial return in the organization of an agricultural college, and outside of a short-lived attempt, no other agricultural college but this institution has entered the field.

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[1] General contribution from College of Agriculture No. 267.

Agriculture being an unrecognized profession the students practically had no job waiting for them on graduation, but with the development of agricultural consciousness, each year marks a greater demand for professionally trained agriculturists. Most of the graduates of the College now are placed some time before graduation.

The College of Agriculture has never had occasion to become a diploma mill. There never was a wholesale demand for its graduates. Because of this, it has been possible to maintain high standards from the beginning, subjecting the students throughout their period of training to the rigid mental and physical tests as demanded by the profession. With the years there has been an improvement in the quality and volume of the subject matter taught, largely the output of the College's own research activities. Consistent improvement has also taken place in the plant, equipment, and laboratory facilities, as well as in the preparation of the teaching staff. Recent changes that cannot but have far reaching effects are the elevation of entrance requirements to that of high school graduates, and the adoption of an elastic curriculum that gives during the first two years and a half a broad training in agricultural fundamentals and the basic sciences and allows specialization along a narrow line the last year and a half. With the further policy of curtailing enrollment to the facilities available for the best work, the College can face the future with equanimity both for the institution and for its students.

B. M. Gonzalez
Dean, College of Agriculture.

The report of the Committee on Methods of Selection, Retention, and Promotion of Undergraduates to the Association of University Professors concludes and recommends:

"That it should be the policy of every college to admit a student for a limited period only, and to expect that at the end of that period the student who desires to continue shall have established a clear affirmative case for his retention and promotion."

What The Colleges Are Doing.

OBSERVATIONS ON THE BREEDING ACTIVITIES OF CARABAOS[1]

VALENTE VILLEGAS
Of the Department of Animal Husbandry

Our knowledge of the breeding activities among carabaos is meager. Additional data bearing on this subject would be useful in determining a number of points of economic interest to animal breeders.

The objects of the work presented in this paper were as follows: (1) To know the age of carabaos at the time first conception takes place; (2) to find out the age when first calving occurs; (3) to ascertain the period intervening between calvings; and (4) to determine the rest period, or the interval elapsing between the time of calving and the succeeding date when conception takes place.

Data reported in this work are on carabaos belonging to the College of Agriculture, University of the Philippines. Through the courtesy of the Philippine Bureau of Animal Industry, data on breeding of some of their carabaos at the La Carlota Experiment Station, Occidental Negros, are also incorporated. This investigation includes data from May 2, 1913, to November 23, 1929, covering a period of 16 years, 6 months, and 21 days.

ANIMALS

Table 1 shows the breeding, date of birth, and date of first calving of the different carabaos used in this work. Altogether there were 26 animals observed in this investigation, of which 14 were natives, 6 Indian buffaloes, and 6 grades. The grades were all Indian buffalo-native carabao crossbreeds, except Herd No. 43 which is of ¾ Indian buffalo-¼ native carabao breeding.

MANAGEMENT OF ANIMALS

All carabao cows reported in this paper were raised on the range. To insure their breeding, bulls were kept in the herds at all times, the number of cows alloted to each bull being ten or less. The heifers were kept with the bulls from birth so that the first calvings they showed represent the product of the first fertile matings among them.

DISCUSSION OF RESULTS

Age at first fertile mating

The age at first fertile mating was obtained by subtracting 320 days, or the period of gestation among native carabaos[2], from the age at first calving. As may be seen in table 2, the age at first fertile mating among native carabaos varied from 1 year, 7 months, and 26 days to 2 years, 10 months, and 28 days, the average age being 2 years, 5 months, and 5 days. With the Indian buffaloes, the age ranged from 1 year, 11 months, and 10 days to 2 years and 7 months; the average age is 2 years, 2 months, and 14 days. The variation among the grades was from 1 year, 10 months, and 21 days to 2 years, 8 months, and 26 days, the average age being 2 years, 3 months, and 24 days.

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[1] Experiment station contribution No. 644. Received for publication February 15, 1930.

[2] Gonzalez, B. M., 1919. The gestation of the carabao. Journal of Heredity **10**: 374–375. Fig. 1.

Taking all of the animals together, the average age at first fertile mating was 2 years, 4 months, and 7 days.

Age at first calving

Table 2 shows that among the native carabaos the youngest animal calved at the age of 2 years, 6 months, and 11 days, the oldest at the age of 3 years, 9 months, and 13 days, the average age at first calving being 3 years, 3 months, and 20 days. With the Indian buffaloes, the youngest age at first calving was 2 years, 10 months, and 1 day; the oldest age was 3 years, 5 months, and 21 days, the average age being 3 years and 29 days. With the grades, the youngest age at first calving was 2 years, 9 months, and 12 days, and the youngest 3 years, 7 months, and 17 days, the average age being 3 years, 2 months, and 9 days.

The average age at first calving of all the carabaos observed was 3 years, 2 months, and 22 days.

Interval between calvings

The data in table 3 were obtained from a total of 105 calvings. It is obvious that among the native carabaos the average interval between calvings was 533.6 days, the shortest interval being 361 days, and the longest, 1356 days. The average interval with the Indian buffaloes was 625.5 days, the range being from 349 to 792 days. In regard to the grades, the average was 456.1 days, the interval varying from 346 to 749 days. The average interval with all the carabaos considered was 535.6 days.

Referring to table 4, it may be noted that 55.56 per cent of the cases showed the intervals between calvings with all the carabaos to occur between 361 and 450 days, while 9.88 per cent fell between 451 and 540 days. Therefore, over 65 per cent gave the interval between calvings at approximately between 1 and 18 months.

Rest period

The rest period was calculated by subtracting the period of gestation of carabaos from the interval between calvings.

According to table 3, the shortest rest period in native carabaos was 20 days, and the longest was 1036 days, the average being 213.6 days. With Indian buffaloes, the range was from 29 to 522 days, and the average was 305.5 days. The grades showed a variation from 26 to 429 days, and an average of 136.2 days. The average rest period with all the carabaos observed was 215.6 days.

Table 5 shows the frequency distribution of rest period with all the carabaos observed to be 51.85 per cent between 31 and 120 days, and 12.34 per cent between 121 and 210 days. In other words, over 64 per cent of the cases showed a rest period of approximately one to seven months duration.

SUMMARY

1. The data presented for the age at first fertile mating and age at first calving were obtained from 26 carabaos, of which 14 were native, 6 were Indian buffaloes, and 6 were grades. The interval between calvings and the rest period were computed from 105 calvings of 21 carabaos composed of 11 natives, 5 Indian buffaloes, and 5 grades.
2. The average approximate age at first fertile mating with all the animals studied was 2 years, 4 months, and 7 days.
3. The average age at first calving was 3 years, 2 months, and 22 days.
4. The average interval between calvings was 535.6 days. The majority of the cases, constituting over 65 per cent, showed an interval ranging from 1 to 18 months duration.
5. The average rest period, or the time elapsing between one calving and the following conception, in all carabaos was 215.6 days. Over 64 per cent gave a rest period ranging from 1 to 7 months interval.

TABLE 1

Herd and property number, breeding, date of birth and date of first calving of carabaos

ANIMAL	DATE OF BIRTH	DATE OF FIRST CALVING
	Native carabaos	
C. A.[a]		
Herd No. 9	July 15, 1917	Nov. 17, 1920
11	Oct. 14, 1917	Nov. 2, 1920
14	Nov. 19, 1918	May 8, 1922
16	May 15, 1919	Nov. 20, 1921
18	Oct. 24, 1920	Aug. 1, 1924
20	Nov. 17, 1920	Aug. 13, 1924
22	Oct. 29, 1921	June 5, 1925
31	Dec. 17, 1922	May 29, 1926
39	May 9, 1925	July 18, 1928
B. A. I.[b]		
Prop. No. 19	May 2, 1913	July 5, 1916
27	Feb. 27, 1914	April 1, 1917
31	June 30, 1914	Aug. 19, 1917
48	Jan. 28, 1916	April 27, 1919
138	July 20, 1917	Dec. 7, 1920
	Indian Buffaloes	
C. A.		
Herd No. 5	July 1, 1919	Dec. 17, 1922
7	July 11, 1921	July 18, 1924
10	Nov. 22, 1922	Dec. 7, 1925
11	Dec. 17, 1922	Dec. 19, 1925
15	March 18, 1925	Jan. 11, 1929
16	Oct. 26, 1925	Dec. 3, 1928
	Grades	
C. A.		
Herd No. 21	Sept. 9, 1921	Nov. 11, 1924
29	Nov. 27, 1922	July 10, 1926
32	Feb. 9, 1923	May 28, 1926
36	Aug. 1, 1924	July 8, 1927
38	Dec. 11, 1924	Sept. 17, 1927
43	Oct. 22, 1925	Feb. 13, 1929

[a] C. A. = College of Agriculture.

[b] B. A. I. = Bureau of Animal Industry.

TABLE 2

Age at first fertile mating and at first calving of carabaos

ANIMAL	AGE AT FIRST FERTILE MATING	AGE AT FIRST CALVING
	Native carabaos	
C. A. Herd No. 9	2 yrs., 5 mo., 22 da. (902 da.)	3 yrs., 4 mo., 7 da. (1222 da.)
11	2 yrs., 2 mo., 6 da. (796 da.)	3 yrs., 21 da. (1116 da.)
14	2 yrs., 7 mo., 7 da. (947 da.)	3 yrs., 5 mo., 22 da. (1267 da.)
16	1 yr., 7 mo., 26 da. (601 da.)	2 yrs., 6 mo., 11 da. (921 da.)
18	2 yrs., 10 mo., 28 da. (1058 da.)	3 yrs., 9 mo., 13 da. (1378 da.)
20	2 yrs., 10 mo., 15 da. (1045 da.)	3 yrs., 9 mo., 10 da. (1365 da.)
22	2 yrs., 8 mo., 25 da. (995 da.)	3 yrs., 7 mo., 10 da. (1315 da.)
31	2 yrs., 7 mo., (940 da.)	3 yrs., 5 mo., 15 da. (1260 da.)
39	2 yrs., 3 mo., 21 da. (847 da.)	3 yrs., 2 mo., 12 da. (1167 da.)
B. A. I. Prop. No. 19	2 yrs., 3 mo., 15 da. (841 da.)	3 yrs., 2 mo., 6 da. (1161 da.)
27	2 yrs., 2 mo., 13 da. (810 da.)	3 yrs., 1 mo., 5 da. (1130 da.)
31	2 yrs., 3 mo. (827 da.)	3 yrs., 1 mo., 22 da. (1147 da.)
48	2 yrs., 4 mo., 9 da. (865 da.)	3 yrs., 3 mo. (1185 da.)
138	2 yrs., 6 mo., 1 da. (917 da.)	3 yrs., 4 mo., 22 da. (1237 da.)
Average	2 yrs., 5 mo., 5 da. (885 da.)	3 yrs., 3 mo., 20 da. (1205 da.)
	Indian buffaloes	
C. A. Herd No. 5	2 yrs., 7 mo., (946 da.)	3 yrs., 5 mo., 21 da. (1266 da.)
7	2 yrs., 1 mo., 18 da. (784 da.)	3 yrs., 9 da. (1104 da.)
10	2 yrs., 1 mo., 26 da. (791 da.)	3 yrs., 16 da. (1111 da.)
11	2 yrs., 1 mo., 13 da. (778 da.)	3 yrs., 3 da. (1098 da.)
15	1 yr., 11 mo., 10 da. (711 da.)	2 yrs., 10 mo., 1 da. (1031 da.)
16	2 yrs., 2 mo., 19 da. (815 da.)	3 yrs., 1 mo., 10 da. (1135 da.)
Average	2 yrs., 2 mo., 14 da. (804 da.)	3 yrs., 29 da. (1124 da.)
	Grades	
C. A. Herd No. 21	2 yrs., 3 mo., 14 da. (840 da.)	3 yrs., 2 mo., 5 da. (1160 da.)
29	2 yrs., 8 mo., 26 da. (1002 da.)	3 yrs., 7 mo., 17 da. (1322 da.)
32	2 yrs., 4 mo., 28 da. (884 da.)	3 yrs., 3 mo., 19 da. (1204 da.)
36	2 yrs., 15 da. (753 da.)	2 yrs., 11 mo., 13 da. (1073 da.)
38	1 yr., 10 mo., 21 da. (692 da.)	2 yrs., 9 mo., 12 da. (1012 da.)
43	2 yrs., 5 mo., 5 da. (891 da.)	3 yrs., 3 mo., 26 da. (1211 da.)
Average	2 yrs., 3 mo., 24 da. (844 da.)	3 yrs., 2 mo., 9 da. (1164 da.)
General Average	2 yrs., 4 mo., 7 da. (857 da.)	3 yrs., 2 mo., 22 da. (1177 da.)

TABLE 3

Interval between calvings and rest period among carabaos

ANIMALS	INTERVAL BETWEEN CALVINGS	REST PERIOD
	days	*days*
	Native carabaos	
C. A.		
Herd No. 1.......	670	350
	416	96
	434	114
	445	125
	943	623
	418	98
	381	61
	373	53
	429	109
Herd No. 4.......	413	93
	381	61
	412	92
	870	550
	398	78
	373	53
	436	116
Herd No. 9.......	931	611
	546	226
	392	72
	431	111
	362	42
	379	59
Herd No. 11.......	361	41
	409	89
Herd No. 18.......	433	113
	386	66
	348	28
	369	49
Herd No. 39.......	424	104
B. A. I.		
Prop. No. 19......	448	128
	516	196
	404	84
	1086	766
	483	163
	1356	1036
Prop. No. 27......	445	125
	423	103
	404	84
	482	162
	604	284
	350	30
	1141	821
Prop. No. 31......	905	585
	418	98
	720	400
	Native carabaos	
	374	54
	537	217
	419	99
	372	52
Prop. No. 48......	377	57
	1178	858
	390	70
	361	41
	765	445
	393	73
Prop. No. 138.....	964	644
	430	110
	433	113
	741	421
Average...........	533.6	213.6
	Indian buffaloes	
C. A.		
Herd No. 3.......	717	397
	792	472
Herd No. 4.......	742	422
	500	180
	842	522
Herd No. 7.......	466	146
	366	46
	349	29
Herd No. 10.......	647	327
	802	482
Herd No. 11.......	658	338
Average...........	625.5	305.5
	Grades	
C. A.		
Herd No. 12.......	346	26
	476	156
	629	309
	362	42
Herd No. 29.......	391	71
Herd No. 32.......	520	200
	368	48
	378	58
Herd No. 36.......	392	72
	407	87
Herd No. 38.......	749	429
Average...........	456.1	136.2
General Average...	535.6	215.6

TABLE 4

Frequency distribution of intervals between calvings among 21 carabaos, involving 105 calvings

CLASS VALUE	FREQUENCY	PERCENTAGE
360 or less	4	4.94
361— 450	45	55.56
451— 540	8	9.88
541— 630	3	3.70
631— 720	5	6.17
721— 810	6	7.41
811— 900	2	2.47
901— 990	4	4.94
991—1080	0	0.00
1081—1170	2	2.47
1171—1260	1	1.23
1261—1350	0	0.00
1351 or over	1	1.23
Total	81	100.00

TABLE 5

Frequency distribution of rest period among 21 carabaos, involving 105 calvings

CLASS VALUE	FREQUENCY	PERCENTAGE
30 or less	4	4.94
31— 120	42	51.85
121— 210	10	12.34
211— 300	3	3.70
301— 390	4	4.94
391— 480	7	8.64
481— 570	3	3.70
571— 660	4	4.94
661— 750	0	0.00
751— 840	2	2.47
841— 930	1	1.23
931—1020	0	0.00
1021 or over	1	1.23
Total	81	99.98

TWINE AND SACK MAKING AS A POSSIBLE HOME INDUSTRY IN THE PHILIPPINE ISLANDS[1]

EULALIO P. BALTAZAR
Of the Department of Agronomy

WITH EIGHT TEXT FIGURES

According to Mr. de la Rama, Acting Director of the Philippine Bureau of Commerce and Industry, the importations of empty jute bags and jute fabric for the last eight years were as follows:

TABLE 1

Amount and value of empty jute bags, burlap and bagging, imported into Philippine Islands during 1921-1929

YEAR	NUMBER OF EMPTY BAGS	VALUE	BURLAP AND BAGGING (JUTE)	VALUE
		pesos	*sq. m.*	*pesos*
1921.....	7,112,562	1,408,171	2,534,200	353,507
1922.....	7,056,540	1,177,582	6,741,663	835,034
1923.....	5,192,551	1,041,532	7,643,766	1,315,494
1924.....	3,465,516	729,882	9,495,218	1,568,246
1925.....	4,033,022	1,240,525	12,631,421	2,755,838
1926.....	6,059,426	1,658,704	10,919,982	2,531,534
1927.....	7,499,901	1,674,548	12,398,686	2,269,642
1928.....	7,279,346	1,662,548	12,314,611	2,386,892
1929.....	8,340,165	2,104,527	14,542,665	3,181,132

These bags and burlap are used for bagging our rice, copra, and sugar products.

The Philippines is rich in bast-fiber bearing plants from which suitable material may be made for the manufacture of bagging, twine, rope, etc. These plants are found in almost all parts of the Philippines and are available at any time of the year. Were the bag-making developed as a home industry, Filipino farmers could use their own bagging instead of that from India.

Most of the shrub bast-fiber bearing plants of the Philippines mature at the beginning of the dry season which is in October. At this time of the year, the Filipino farmers do not have much to do as the rice crop is just beginning to mature. In this idle period they could cut down fiber plants and ret them, and make the bagging and bags ready for sacking their palay when it is threshed. That there is interest in this matter is shown by the inquiries about twine and sack making that are received by the Division of Fiber and Oil Plants of the Agronomy Department of this College. In order to answer these inquiries and to teach our farmers the different steps involved in twine and sack making, the present paper has been prepared. The method herein described for twine and sack making is not perfect: but it will answer. Further improvement will be made in the future.

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[1] Experiment Station contribution No. 645. Received for publication April 7, 1930.

[2] The writer is under deep obligation to Dr. Nemesio B. Mendiola, Head of the Department of Agronomy, for his valuable criticisms and suggestions during the preparation of this paper.

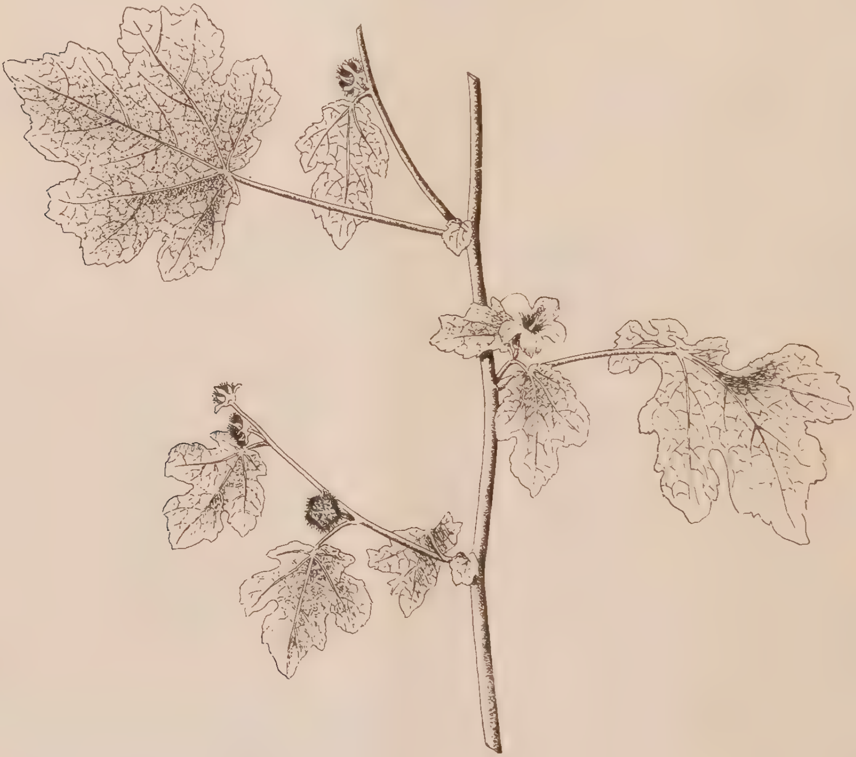

Fig. 1.—*Urena lobata* (Kollokollót).

BAST-FIBER BEARING PLANTS

Among the bast-fiber bearing plants found in the Philippines are *Urena lobata* Linn., *Triumfetta bartramia* L., *Corchorus capsularis* L., *Corchorus olitorius* L., *Malachra fasciata* L., *Crotolaria juncea* L., *Hibiscus sabdariffa* L., *Hibiscus tiliaceus* L., *Hibiscus cannabinus* L., *Abroma fastuosa* L., *Abroma augusta* L., *Grewia multiflora* L., *Bombycidendron vidalianum* Merr. and Rolfe, *Pterocymbium tinctorium* (Blanco) Merr.

Only *Urena lobata* L. has been tried so far as a source of fibers for twine and sack making. It is known as *anonongkót* or *barang-gót* among the Bicols; *kulut-kulutan* among the Tagalogs and Visayans and *kollokollót* among the Ilocanos. (See fig. 1.)

Urena lobata is an erect plant from one to two meters in height. The leaves are hairy, sometimes entire in form, sometimes, three-lobed. The flowers are small, violet in color. The fruit is small, spherical in form and provided with spines.

PREPARATION OF THE FIBER FOR MAKING TWINE

Cutting. The bast-fiber bearing plants are cut down as close as possible to the ground. If some prop roots appear above the surface of the ground, it is advisable to cut the plants a little higher, say two or three centimeters above the ground. This is to eliminate the roots and other parts of the plants that delay the extraction of the bast fibers. After cutting down the plants, they are either allowed to stay in the field for at least three days so as to let the leaves wilt and fall off from the plants before retting, or they are taken directly to the retting place. Any small side branches that interfere in bundling the plants are cut off. If the stream or pool in which the plants are retted is deep and wide, there is no need for cutting off the leaves or twigs, thus saving labor.

Retting. After the cut plants have been tied into bundles, they are immersed in water in a stagnant pool or running stream. If neither of these is available, a concrete tank about 2.4 meters long, 1.2 meters wide, and 1.2 meters deep will suffice. This tank should be provided with an outlet in one corner for drawing off the dirty water which remains after retting the plants.

The number of days it takes to ret the materials depends upon the condition of the plants used. It takes at least three weeks to ret plants that are allowed to stay in the fields for at least three days after cutting before they are tied in bundles. Materials that are immersed immediately after cutting will take at least eight or ten days to ret. If the bark containing the bast fibers is peeled off from the woody portion of the plant just after cutting it and the materials dipped into the water at once, it takes only seven or eight days to ret. As soon as the materials show sign of decay, they are removed from the water. In case a running stream is used in retting the fibers, they need not be removed as the running water enables the worker to remove the decomposed materials from the fiber. The outer layer of the bark containing the dead, black dirty cells is removed by carefully scraping it off with a dull thin flat stick. When these cells are removed, the bast-fibers are thoroughly washed. If the materials have been retted in salt water, they should be thoroughly washed in sweet water so as to remove all traces of salt as it will prevent thorough drying and thus weaken the fibers. The fibers are hung and spread on a long horizontal pole, or spread on dry ground. When thoroughly dried they are collected.

According to Mendiola (1917)[3] the number of days required to ret the following fibers in running water is: eight days for *Abroma augusta* L.;

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[3] Mendiola, Nemesio Blanco. 1917. A study of Philippine bast fibers. The Philippine Agriculturist and Forester **6**: 6–38. Pl. 1-4.

eleven days for *Kleinhofia hospita* L.; eighteen days for *Urena lobata* L.; ten days for *Hibiscus sabdariffa* L.; nine days for *Malachra capitata* Jacq.; four to six days for *Triumfetta bartramia* L.; twenty-two to twenty-seven days for *Malachra fasciata* L.; four to six days for *Grewia multiflora* Juss.;

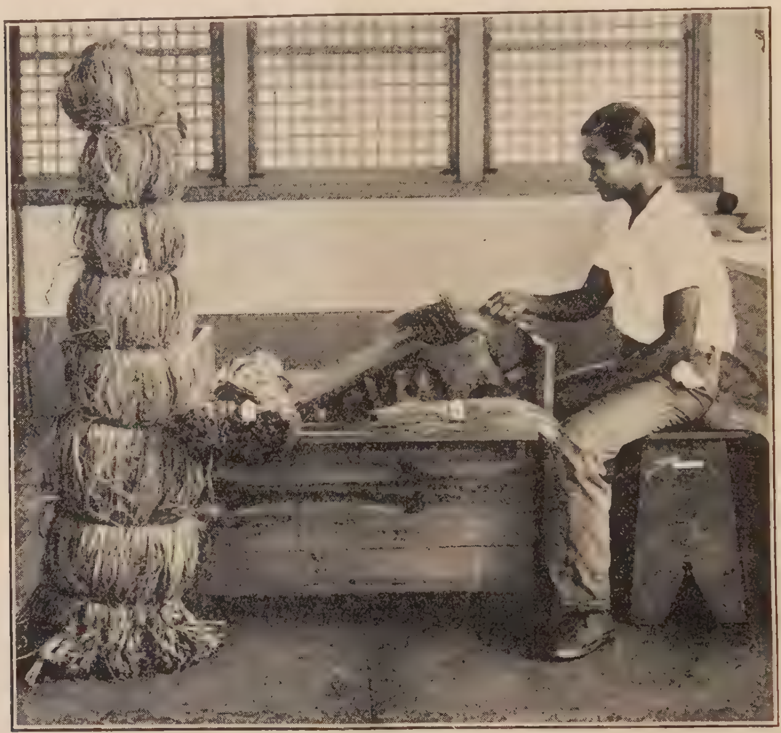

Fig. 2.—Showing the method of hackling fiber. (1) A bundle of *Urena lobata* fiber (*Kulot-kulotan*) which has not been batched with oil and water; (2) is the same kind of fiber that has been batched; (3) shows the process of hackling fiber; (4) represents the fiber that has been cleaned and hackled.

and five to eight days for *Sesbania grandiflora* Pers. In the General Experiment Station in Java, according to the same author, fibers of *Hibiscus* species are retted as follows: The plants are first cut down as close as possible to the ground. Then, all the bast, including the bark, is pulled from the semi-woody portion of the plant and taken to the place of retting. The leaves, twigs, branches and the woody portion of the plant are left in the field. This method has a number of advantages: less retting space is required as the leaves, twigs, branches and trunks have been left in the field; less labor is required to ret the fibers; time is saved as the fibers take only about six or seven days to ret.

Batching. The application of oil and water upon the fibers to render them soft is called batching. This process is necessary before combing out and hackling the fibers. A batch of water and oil in the proportion of five liters of water and one liter of paraffin oil can be applied to about 30 kilograms of fiber. The combing, hackling, and spinning qualities of the fiber are much improved by batching, as it makes the fibers soft, smooth, pliable, and glossy, and makes spinning and weaving easier as the fibers do not break so frequently. Also the fibers easily separate in hackling if they are batched with oil and water. The best time to batch the fibers is just after they have been thoroughly dried in the sun, as they are still soft, smooth and somewhat oily. If the fibers are always batched before being spun into twine, much waste is prevented for the fibers that are hard and

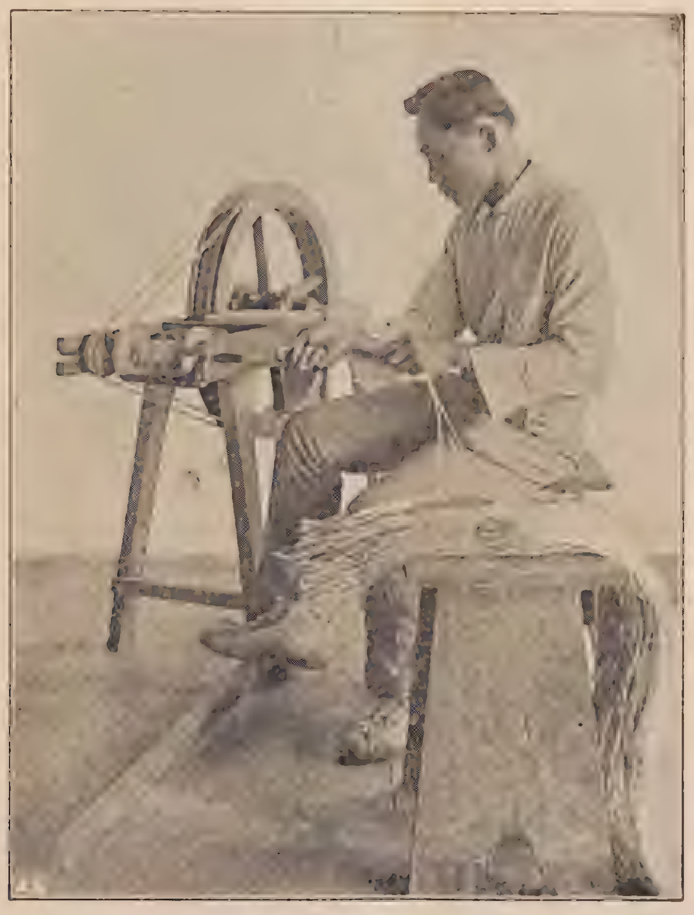

Fig. 3.—Showing the method of twisting the fiber into twine. Note the way the worker manipulates the revolving machine.

considered to be useless when not batched can be utilized when they are so treated.

Combing. After the fibers are thoroughly dried and properly batched, combing follows unless the fibers have been well retted. The object of combing the fibers is to separate them and to break any hard sticky portion of the material. Combing facilitates hackling as the individual fibers are separated.

Hackling. The process of breaking the fibers by passing them through a simple device that cleans them is called hackling. This device is a board through which sharp pointed nails have been driven about a half a centimeter apart. Hackling is done as follows: take a bundle of fibers about two centimeters in diameter and strike it against the hackling device. Repeat this until the fibers are loose and free from dirt. If fine fibers are desired, it is advisable to use a hackle with the sharp points only about two millimeters apart. The latter kind of hackle is more efficient than the former. (See fig. 2). Both kinds of hackle are used in the College of Agriculture.

Preparation of twine. After the fibers are combed and hackled they are ready to be spun into twine. For this purpose a revolving machine is used. The machine in the College of Agriculture is made almost wholly of wood.

This machine is very simple; it has a large wheel about 60 cm. in diameter, with an iron axle of about 2 cm. The wheel is mounted on a wooden frame about 65 cm. high, 100 cm. long and 20 cm. wide. The wheel is provided with two grooves. On the front end of the frame are two revolving discs, one larger than the other. Each disc has a groove. The grooves of the wheel and the discs are belted together. The machine works as follows: While the wheel is rotated by pressing the treadle that is connected to one end of the axle, the two discs rotate. These two discs are also provided with a long wooden axle on which is a wooden spool if it is desired to twist the twine. As the machine rotates, this spool rotates also and the fibers are twisted into twine. (See fig. 3.)

Making the twine. After combing, batching, and hackling the fibers they are ready to be woven into twine. To make twine, proceed as follows: Place the cleaned hackled fibers on a stand near the machine. Put a wooden spool on the axle of the two wooden discs. The discs together with the wooden spool should be connected by passing a small cylindrical peg through the holes of the discs so that, when the wheel rotates, the discs and the wooden spool will also rotate. To facilitate weaving it is necessary to have a hook to catch the end of the twine whenever it is broken. Pass the end of the twine into the hollow end of the wooden axle. Now rotate the machine by pressing the treadle bar. As the machine rotates, the fibers that are inserted through the hollow end of the wooden axle are twisted into twine because the wooden spool rotates, thereby twisting the fibers. When the first load of fibers fed into the revolving spool is about consumed, feed again the rotating wooden spool. It is advisable to hold fibers in the hand all the time so as to be ready to feed the machine as soon as the fibers being twisted are consumed. An experienced worker can hold the fibers in his left hand and feed the machine with his right. One who is proficient in the manipulation of this machine can twist from 80 to 100 meters of twine, one to two millimeters in diameter in one hour.

Treatment of the fiber preparatory to making sacking. Starching the twine is necessary before it is woven into sacking if the fibers have not been batched with water and oil. Twine suitable for warp becomes fluffy and rough whenever the batten is pressed against the woof if it is not either starched or batched. When the warp twine becomes fluffy it frequently breaks because it does not allow the batten to pass through easily, hence weaving is more difficult and the twine breaks.

Arrow-root flour has been found to be the best material for starching twine, but it is not always available in all parts of the Philippines. When it is not available, any form of *gaogao*, such as cassava, canna, rice or wheat flour may be used. Make the flour into a thick paste. Stretch the twine by tying it to two vertical poles. Put some paste on a piece of paper. Press the twine against this paper. To prevent the twine from sticking together after applying the paste, pass the ends through holes in a flat board. Push the board as you apply the paste.

Soft wax or paraffin should be rubbed over the twine after starching it to insure easy weaving. It is not necessary to starch woof twine.

EQUIPMENT USED FOR WEAVING SACKING

The process of weaving sacking is similar to that of weaving cotton cloth. An ordinary loom which is used for weaving cotton fabrics can be used for weaving sacking. However, some of the accessories of the ordinary loom as the reed, the shuttle, the heddle horse, the heddle bars or sticks, and heddle threads have to be modified before they can be used for sacking. (See fig. 4.)

The *reed* of an ordinary loom is a long comb which fits into the batten. The frame of the reed is usually made of bamboo. The teeth are spaced about one millimeter apart. The reed together with the batten either pushes or presses the woof to its proper place. In weaving gunny sacking this kind of reed cannot be used. The teeth must be spaced farther apart, 1½, 2, 3 or 4 cm., depending upon the kind of sacking that is to be woven.

The *shuttle* which is used for weaving sacking may be made of narra or camagon wood, and is much larger than the one which is used for weaving cotton cloth. Ordinarily, a cotton cloth shuttle is about 30 cm. long, 3 cm. wide and 2 cm. broad at its middle portion. A sacking shuttle is about

35 cm. long, 6 cm. wide, and 4.5 cm. broad. Its cavity is much larger than that of the cotton cloth shuttle. Inside the shuttle is a cylindrical bar 15 cm. long and about 1 cm. in diameter, which is held in place by fitting it into the holes of the shuttle. A small hollow bamboo about 14 cm. long and a little over 1 cm. in diameter containing the woof is held in place by passing the bar of the shuttle through the cavity of this tube. When the shuttle is shot through the shed of the warp twine, the hollow bamboo containing the woof rotates, enabling the weaver to intercross the woof twine with the warp. If this kind of shuttle is not available, a piece of bamboo or wood cylindrical in shape about 10 cm. long and provided with a claw at each end will answer although the weaving is rather slow, as the weaver has to untie the twine from it whenever she passes it through the shed.

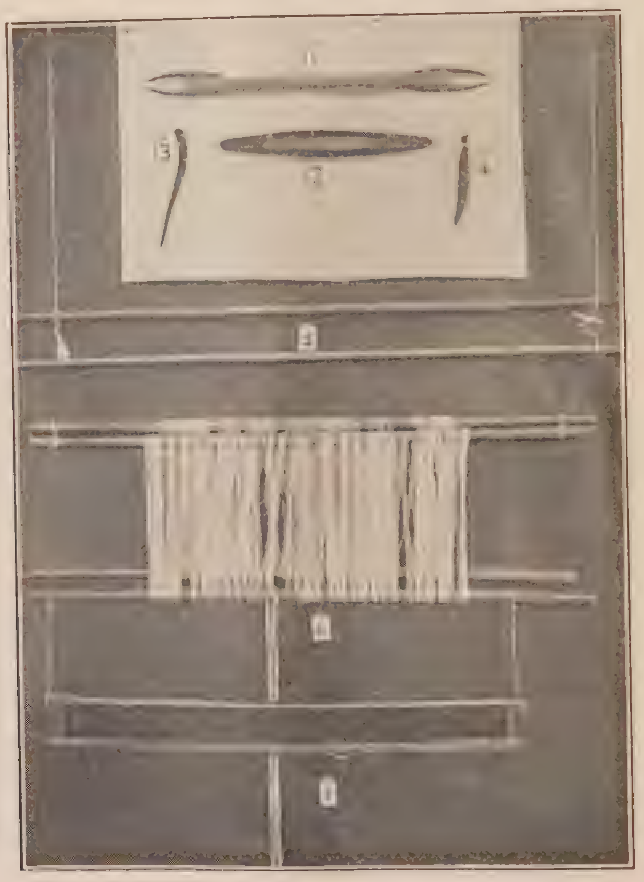

Fig. 4.—Accessories of an ordinary loom needed for weaving sacking. (1) A shuttle commonly used for weaving coarse sacking; (2) another kind of shuttle for weaving fine sacking; (3) and (4) are two kinds of reed hooks for threading the reed; (5) lease rods, (6) heddle threads and sticks, (7) a reed

A bamboo cylindrical bar about two meters long and five cm. in diameter can be substituted for the pulley or the heddle horses of the ordinary loom. A strong cord is wound around each end of this cylindrical bamboo and is connected to the heddle bars by means of this cord. When the treadles are pressed by the feet, the heddle bars go up and down as the cord connecting the bamboo bar and the treadles is moved upward or downward.

The heddle bars or sticks in the ordinary loom for weaving cotton cloth are made of a cylindrical piece of wood or bamboo about 75 cm. long and with a diameter of about 2 cm. As many as from two to six are used in weaving cloth. In weaving gunny sacking, two heddle bars about 80 cm. long and 2.5 cm. in diameter are needed. These heddle bars lower or raise the heddle threads so as to separate the warp twine into two divisions. When the warp twine is separated, the shuttle containing the woof twine is then shot through the gap, or shed of the said division.

The heddle thread of an ordinary loom for weaving cotton fabric is a woven net-like structure about 20 cm. wide and 60 cm. long. It has two rows of knots, one below and the other above. The distance between the knots is about 8 cm. This distance forms the opening of the shed of the warp twines when one of the treadles is pressed by one foot. The opening of the shed so formed is wide enough to admit the shuttle when inserted or thrown through it.

In weaving gunny sacking, it is necessary for the weaver to change the heddle twine. She should use one with stronger twine about 25 cm. wide and 70 cm. long. The distance between the knots should be at least 10 cm.

The warp beam is a cylindrical piece of wood of either molave or narra. It is about 1.5 meters long with a diameter of about 10 cm. Two horizontal wooden bars are attached to the back main posts of the loom. The warp beam is provided with a handle. The handle is used for turning the beam so as to either loosen or tighten the warp twine.

The lease rods take the place of the spreader. They are made of two cylindrical pieces of bamboo about a meter long. Two ends are tied together by a cord and the other two ends are open. The free ends are inserted through the crosses of the warp twine so as to spread them uniformly on the warp beam.

The weaver's seat is simply a flat board usually about one and a half meters long and one fifth of a meter wide. Its ends are attached to the side frame of the loom. The sack beam or cloth beam is turned around so as to roll the woven stuff.

The batten is made of two parallel horizontal boards about 1.5 meters long. The width of the space between these two boards is about 15 cm. These two boards are kept in place by means of two parallel vertical boards which are attached to the top frame boards of the loom. The batten together with the reed pushes or presses the woof twine in its proper place.

Two treadles are needed for weaving sacking. They are usually made of bamboo. They are a lever device pressed by the feet so as to make the heddle bars with the heddle threads go up and down.

WEAVING OPERATIONS

After the twine has been starched or made smooth by the application of soft beeswax or paraffin, they are wound on a spool by using a revolving device, such as the *pagpudunan* and the *ul-lao* of an Ilocano loom. In weaving sacking one spool is sufficient, but more will increase amount of work done. After reeling the spool or spools the warp board is threaded.

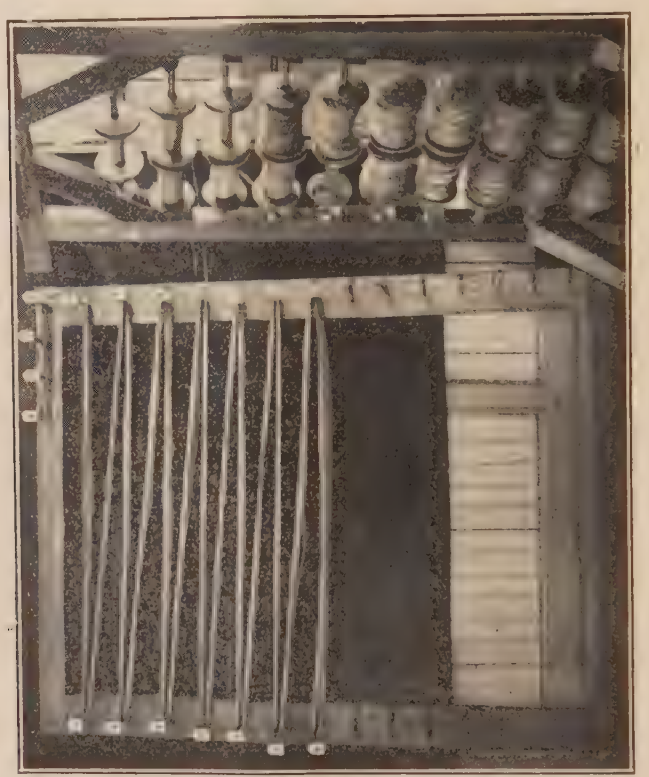

Fig. 5.—Showing the method of arranging the twine on the warp board. Note the arrangement of the twine as it is pulled from the rotating spools on the rack spool.

Arranging the warp. It is on the warp board that the twine is arranged in such a way that all of the twine needed for the piece to be woven is alternately separated, one thread going down and the other going up. To arrange it, the spool of twine is laid upward on the floor and the warp board is placed in front of it. There should be a long round piece of bamboo hung horizontally just above and parallel to the spool so that as the twine is pulled from the spool, it goes up over this bamboo, then is pulled down ready to be wound on the warp board. The piece of bamboo allows the twine to be unwound from the spool easily as the twine is arranged on the warp board. The alternation of the threads is done on the first two pegs attached and spaced about 20 cm. apart on one of the longer sides of the warp board.

The free end of the twine from the spool is taken and fastened to peg 1 (see fig. 5), then the twine is carried under peg 2 and over peg 3. The twine is passed over peg 4 and over all the other pegs in order. When the twine is passed around the last peg (No. 18), it goes back to peg 17 following the same course of the twine until peg 3 where it goes on the other side of the peg, that is under peg 3, over peg 2 and under peg 1. One complete course is now finished and the same process is repeated for the second course. The number of courses depends upon the number of threads that compose the width of the sack to be woven. (See fig. 5.)

Securing the crosses. When the warp is finished it will be noticed that between pegs 1, 2 and 3 are crosses formed by the threads. These crosses should be secured by passing a cord through the open spaces at pegs 2 and 3. Then both ends of the cord are tied together so that the upper threads of the warp do not get mixed with the lower ones.

Taking off the warp. The warp is removed first from the last peg (peg 18), and then slipped from the other pegs. As the weaver is taking the warp off the pegs she makes it into a sort of a chain for convenience in handling. The chain is made by making a loop of the free end of the warp. The left hand holds this looped end while the right hand draws a part of the warp through to form another loop. This is continued until the other end is reached. (See fig. 6.)

Attaching the warp to the warp beam. The end of the warp where the crosses are is put on the beam. First the end is pulled from the chain and a bamboo strip about a meter long or longer than the width of the sacking to be woven and three cm. wide is pushed through the space from which peg 1 had been removed. A piece of string a little longer than the strip of bamboo can be tied to each end of the bamboo strip to prevent the threads of the warp from slipping out when they are spread. This bamboo strip is then tied at both ends to the warp beam of the loom. There are holes purposely made on the beam through which the end of the warp is tied securely. The chain is undone little by little to avoid tangling.

Threading the heddles. The weaver now sits in front of the beam just near enough to reach the ends of the warp twine. By means of the lease rods which are placed near the end of the warp twines, the weaver can readily see the order of the thread and separate those of the upper warp from those of the lower. The weaver takes the first warp thread and passes it through the first eye of the heddle just in front of her. After threading the first eye of the first heddle, the whole heddle frame is pushed along.

The second warp thread is caught and passed through the eye of the second heddle that lies just behind the first heddle. This second heddle is pushed along as usual. The third warp thread is again picked up and passed through the second eye of the first heddle. The first heddle is pushed along as usual. The fourth warp thread is picked up and passed through the second eye of the second heddle. The fifth warp thread is similarly caught and passed through the third eye of heddle number 1; the sixth, through the third eye of heddle number 2. The same order is followed until all of the warp threads are used. Great care is exercised in threading the heddles as one mistake may throw the remaining threads out of order and spoil the whole work.

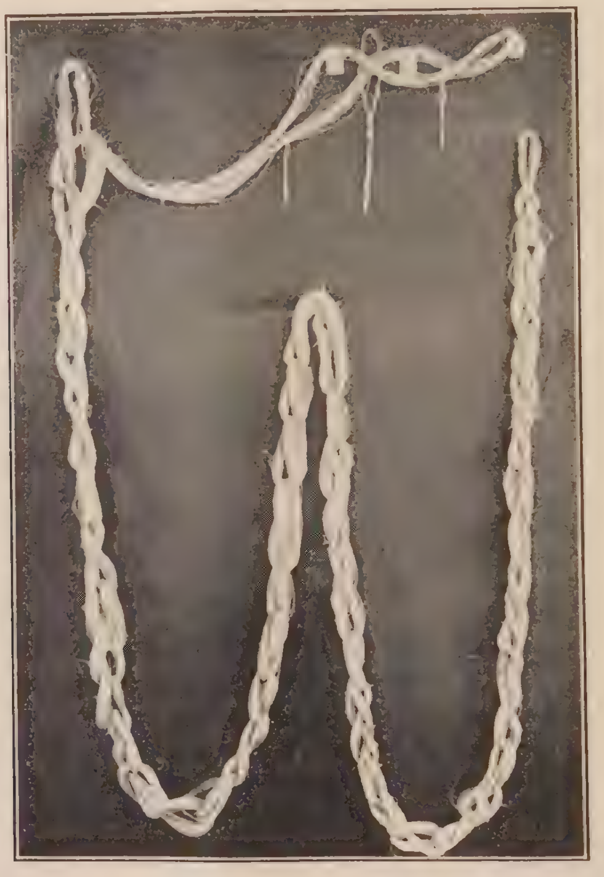

Fig. 6.—Securing the crosses and arranging the twine in a chain. 1, 2 and 3 indicate the places where the crosses are tied. The lease rods are passed through numbers 1 and 2 when the warp twine is mounted on the loom.

Threading the reed. The reed is like a comb about 75 cm. long and 10 cm. wide. It is made of thin pieces of bamboo strips placed closely together in a straight line and tied together with strong string on both sides. The space between each strip is called a dent. The reed is used to put each woof thread in its place and push them closely together. The reed is hung horizontally in front of the heddle threads ready to receive the warp threads in the same order as when they passed through the eyes of the heddle threads. A reed hook made of steel or horn is usually used in passing the warp thread through the dents of the reed. (See Nos. 3 and 4 of fig. 4.) This hook is very thin and smooth so that it can easily slip through the dents of the reed. After threading the reed, it should be placed permanently ready for weaving.

Placing the reed. When the reed is threaded it is then placed between two pieces of wood which are fastened together at both ends to hold it in place. The reed so placed constitutes the batten. The batten is hung on the top of the loom by means of two long bars and can be swung backward and forward. It must hang near enough to the breast beam so that the weaver can easily swing it.

Tying the heddles. The heddles are hung just behind the batten. They are suspended by tying the top heddle sticks with strong cords to the cylindrical horizontal bamboo bar at the top of the loom which serves as the heddle horse. At the center of each of the lower heddle sticks a cord is tied, then carried down to tie with each of the cords coming from the treadles. In pressing one treadle down by one foot, one heddle goes down and the other heddle goes up thus causing the warp threads to divide into two; one half going down and the other half going up.

Attaching the warp to the sack beam. The sack beam is the round roller on which the woven stuff is wound. It is usually put below the breast beam. As soon as the warp threads are drawn out of the reed they are tied together into bunches of about 20 threads each. A rod is pushed behind the knots, then the ends of the rod are tied with a cord a piece of which at the middle is tied to the sack beam. The sack beam is provided with either four holes bored through it or a bamboo bar tied to it through which the cords are to be tied. As the sack beam is turned in, the warp threads are stretched so the woof threads can be woven through them.

The weaving. The batten is swung backward and the shuttle containing the bobbin of twine is thrown by the right hand through the shed. The twine is left on the warp and the batten is again swung to the front placing the woof in its place. The treadle that was just pressed is now released and the other treadle is pressed pulling the other half of the warp down and making the shed open. The left hand throws the shuttle again to the right. The reed is swung forward and the treadles pressed alternately. The shuttle is thrown again and so on, until the piece is woven. (See fig. 7.)

Different grades of sacking can be woven in an ordinary loom. The grade of sacking that is woven depends upon the kind of reed that is used and also upon the size of twine that is used as warp and as woof. When fine sacking is to be made, it is advisable to use fine reed and fine twine, and when coarse sacking is desired, use a reed whose dents are farther apart and a larger twine. (See fig. 8.)

Essentials in weaving sacks. To facilitate weaving the following points should be taken into consideration. When the warp twine is coarse and not uniform in diameter, starch it and then rub it with paraffin or wax so as to make it smooth. Always batch the warp twine with paraffin oil in the following proportions: 5 parts water and 1 part oil if the twine is fine and uniform in diameter; 4 parts water and 1 part oil if it is rather coarse; 3 parts water and 1 part oil if it is very coarse and 2 parts water and 1 part

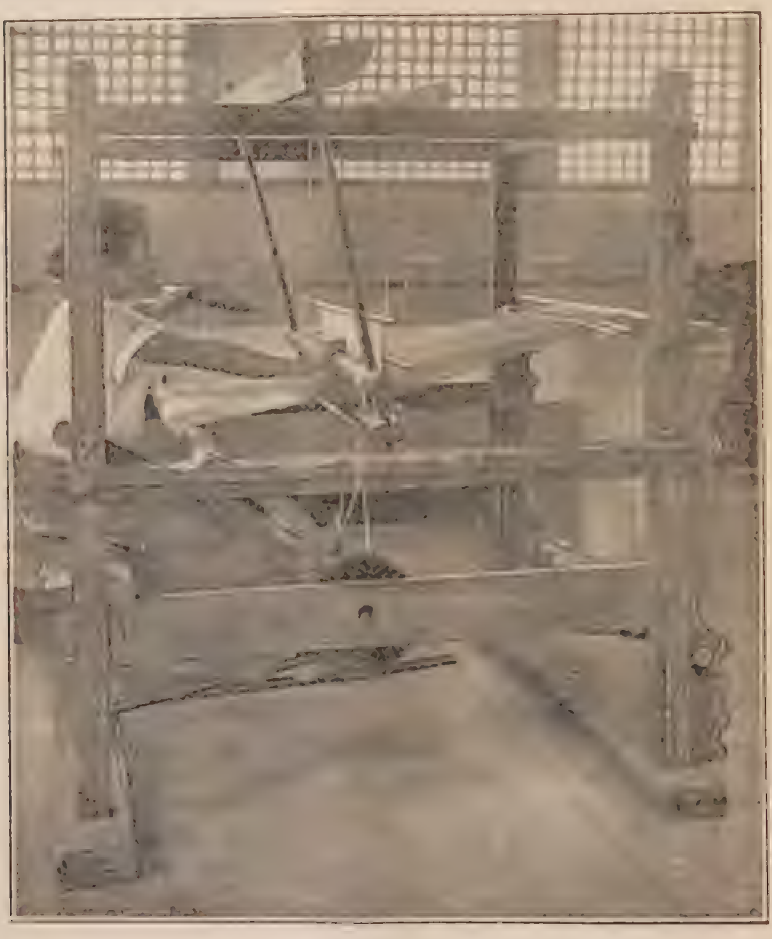

Fig. 7.—An ordinary loom for weaving sacking. The shuttle containing the wound bobbin is about to be shot through the shed of the warp twine. Note the woven sacking just in front of the weaver.

oil if it is very coarse and not very uniform in diameter. Use the ordinary shuttle in weaving fine sacking. Use shuttle No. 1 in weaving coarse sacking.

ECONOMIC CONSIDERATIONS

The cost of making one sack in the College of Agriculture is itemized as follows:

Cost of collecting and retting. According to Mendiola (1917), the cost of collecting and retting 3,696 plants of *Urena lobata* yielding 56.1 kilograms is ₱2.02. An ordinary rice sack 1 meter long and 0.55 meter wide requires around 500 grams of fiber to make it. Basing calculations on these figures, the cost of collecting and retting the fiber necessary to make one sack is about ₱0.04.

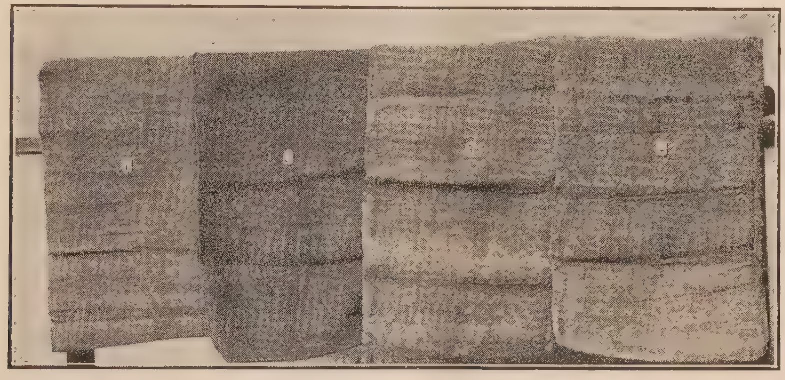

Fig. 8.—Showing the different grades of sacks woven in the College of Agriculture. (1) is used for bagging rice bran (*darac*). (2) for rice; (3) for corn; (4) for copra.

Cost of cleaning and hackling. It takes at least an hour to clean and hackle 500 grams of fiber. Therefore these operations would cost at least ₱0.10.

Cost of making twine. As stated elsewhere in this paper, an ordinary man after gaining some experience in the work should be able to prepare about 100 meters of twine in one hour. A rice sack of the dimensions given above requires around 1400 meters of twine to make it, entailing an expenditure of ₱1.40 at the rate of ₱0.10 per hour.

Cost of batching or starching. The materials and time that are spent in batching enough fiber to make one sack entail an expenditure of around ₱0.05. When the same amount of material is starched, the expenditure incurred is ₱0.10.

Cost of warping and tying the warp. This kind of work requires about two hours. Therefore, at ₱0.10 per hour, the cost is ₱0.20.

Cost of weaving. An ordinary weaver can weave in two hours a meter of sacking 0.55 meter wide. The cost of making one sack is ₱0.20 at the rate of ₱0.10 per hour.

Total cost of production. The above itemized expenses incurred in the manufacture of one sack total either ₱1.89 or ₱1.94, depending on the method used in the treatment of the fiber, that is, whether batched or starched.

SUMMARY OF CONCLUSIONS

1. The making of twine and sacking could be carried on as a home industry in many parts of the Philippines where there are abundant bast-fiber bearing plants growing. Although the unit cost of production of one sack is rather high, still it could be economically made in places where there is much idle labor, and in places where the people are not employed for portions of the year.
2. The method described in this paper of the manufacture of twine and sacking requires only the ordinary native loom. To be adapted to the weaving of sacking, an ordinary loom requires modifications in the parts called the reed, the shuttle, the heddle horse, the heddle bars or sticks, and the heddle threads.

SUMMARY OF RECOMMENDATIONS

1. It is always better to batch the fibers to be used in making twine and sacking than to starch them. It entails less expense.
2. To prevent frequent breakage the use of uniformly twisted twine as warp is recommended.
3. As they break easily, over-retted fibers should not be used in the manufacture of twine and sacking.
4. The cleaning and hackling of fibers should begin just after drying the retted fibers, as at this time they are still soft and oily.
5. The retted fibers should not be exposed to the sun for a long time, as they become hard, brittle, and hard to clean and to hackle.

THE RELATION TO ABACÁ, OR MANILA HEMP, OF THE BANANA-WILT FUNGUS FUSARIUM CUBENSE EFS.[1]

JACINTO B. LEONCIO

WITH TWO TEXT FIGURES

INTRODUCTION

The wilt, or Panama disease, caused by *Fusarium cubense* EFS. is regarded as the most destructive malady of certain species and varieties of banana. On account of the very wide distribution of this fungus in the tropics it seems very likely that the parasite has been associated with the banana ever since it has been cultivated in the Philippine Islands. However, in the Philippines, the wilt disease has never been reported on abacá, or Manila hemp (*Musa textilis* Née), a relative of the banana.

On March 30, 1927, Mr. H. T. Edwards, specialist in Fiber Plant Production of the United States Bureau of Plant Industry, visited the College of Agriculture. He told Doctor Ocfemia that the abacá plants from the Philippines which were introduced into Central America are affected by a disease with symptoms similar to those of the banana wilt. In a letter to Ocfemia from Boston, Massachusetts, dated July 23, 1927, Dr. Otto A. Reinking, Pathologist to the United Fruit Company, stated that "* * * The disease we have on abacá in Central America is without doubt the banana wilt, but further cultural studies will have to be conducted before we can state this definitely. The variety affected out here is the Buñgulanon from Davao. * * *"

Lee and Serrano (1923), Teodoro (1925), and Teodoro and Serrano (1926) report that the heart rot of abacá in the Philippines is due to a fungus similar to, if not identical with *Fusarium cubense*. Ocfemia (1927) does not believe that the vascular fungus *Fusarium cubense* could cause the heart rot of abacá. Experiments conducted by Ocfemia at Los Baños, Laguna, using nearly 2,000 abacá seedlings of different varieties ranging from 150 to 300 days of age, show that *F. cubense* causes vascular infection in abacá similar to that in banana. He found that many of the fast growing abacá seedlings out-grew infection. His experiments further show that this fungus cannot cause heart rot.

The present work is an extension of the work started by Ocfemia. The writer's objects were: (1) to compare the Philippine banana-wilt fungus with Brandes' *F. cubense*; (2) to determine whether or not the banana-wilt

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[1] Thesis presented for graduation, 1930, with the degree of Bachelor of Agriculture from the College of Agriculture, No. 303; Experiment Station contribution No. 646. Prepared in the Department of Plant Pathology under the direction of Dr. G. O. Ocfemia.

Fusarium is capable of infecting abacá seedlings; and (3) to compare the symptoms of the disease on the abacá with those on the banana. The work was conducted in the Department of Plant Pathology of the College of Agriculture from May, 1927, to December, 1929, a period of about 31 months.

MATERIALS AND METHODS

Source of the fungus and how it was isolated

Latundan banana (*Musa sapientum* L. var. *cinerea* (Blco.) Teodoro) plants which showed symptoms of the wilt disease were collected around the vicinity of Los Baños, particularly in Lalakay and taken to the laboratory. The specimens were dissected and examined macroscopically for the presence of the reddish or brownish colored vascular vessels and microscopically for the association of mycelium of the causal fungus in the xylem vessels. Isolations were made from the discolored tissues of the pseudo-stems and corms which had mycelium in the xylem vessels. A *Fusarium* species which agrees very closely with *Fusarium cubense* studied by Brandes (1919) has been constantly isolated. The culture of *Fusarium cubense* which was used in the experiments reported in this paper was isolated from the corm of an infected Latundan which was taken from Lalakay, Los Baños, Laguna. The colored tissues of the corm of a wilt-infected Latundan banana were plated on corn meal in Petri dishes and from the growth transfers were made to slants of potato-dextrose agar. The fungus was allowed to grow until pionnotes were formed.

Source of abacá seedlings and how they were grown

The abacá seedlings used in this study were grown from seeds of three varieties of abacá, namely, Inusa, (Itom × Ilayas) F_1, and Sinibuyas. The seeds were gathered from the abacá plantations of the College of Agriculture and Mendez Nuñez, Cavite. There was some difficulty in germinating the abacá seeds, but good results were finally obtained by planting them in pots of sterilized, finely sifted soil. The pots were partly immersed in water in a pan of galvanized iron outside the laboratory. When the seedlings had three or four leaves they were pricked into other pots of sterile soil.

Source of healthy Latundan banana suckers and how they were grown

Suckers of Latundan banana which were about 60 cm. tall were dug from healthy mother plants. They were collected from the vicinity of the College and from Lalakay, Los Baños.

The suckers were examined critically for the internal symptoms of the wilt disease. Examination was made by cutting off slices from the corms with a sterile knife. This method of examination was followed because the disease can be easily detected by reddish violet color in the corms. All infected or suspicious looking suckers were discarded.

The soil used for planting was taken from an old compost pit at the College of Agriculture. The soil was sifted to eliminate the coarser particles. Some of it was sterilized by heating on galvanized iron, and the remainder was placed in 26-cm. earthen pots which were sterilized in the autoclave for one hour, at 15-pounds' pressure. When the soil was cool, suckers of Latundan banana of uniform size were planted in each pot. Most of the leaves of the suckers were cut off to prevent wilting.

These potted suckers were kept inside the laboratory for four days after which they were placed in a cool shady place outside. The plants were watered daily and allowed to get well started before they were inoculated with the organism.

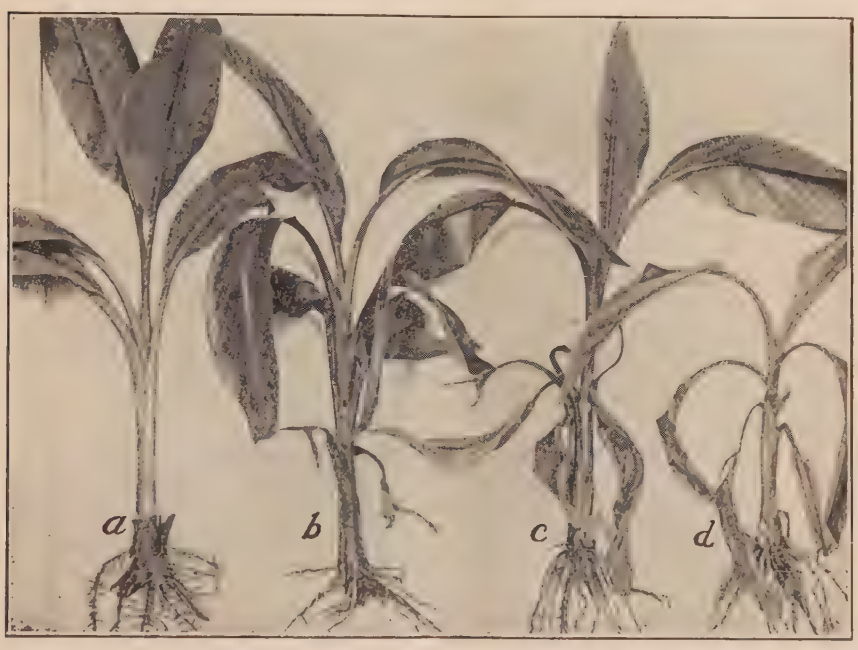

Fig. 1.—Four abacá seedlings of the same age showing differences of (*a*) the control and (*b*, *c* and *d*) the inoculated abacá seedlings. Note the loss of turgidity and drying of the leaves of the diseased seedlings.

THE BANANA-WILT DISEASE

History, geographical distribution, and economic importance

The seriousness of the wilt disease of the banana first attracted attention in Panama and Costa Rica in 1904, although McKenney (1910) believes that the disease existed in those regions as early as 1890. Brandes (1919) states that J. E. Higgins was the first to report the disease in Hawaii in 1904. The banana wilt occurs in Surinam, Jamaica, Cuba, Porto Rico, Trinidad, Barbados, Costa Rica, Nicaragua, Guatemala, Honduras, British

Honduras, Mexico, Hawaii, India, the Philippine Islands, Australia, and probably in the Dutch East Indies and other banana-growing countries.

Brandes considers the banana wilt as one of the most important diseases in Tropical America. This author reports that in 1917 many banana farms in the American tropics were entirely abandoned and some of the plantations were so badly infected by the wilt that bananas could not be grown on them.

In the Philippines the wilt is also one of the most serious diseases of certain varieties of banana. The wilt disease of banana in the Philippines was first reported by Lee and Serrano (1920) in Laguna and Batangas provinces. Ocfemia and Palo (1926) report that the wilt affects chiefly the Latundan, the most common banana grown in the Philippines. In certain places in Laguna the disease has killed thousands of hills and on many farms Latundan cannot be grown profitably because the soil is very heavily infected by the causal fungus (Mendiola and Ocfemia, 1926). Actual counts made by Ocfemia in Lalakay, Los Baños, in 1925 showed that from 84 to 93 per cent of the Latundan are killed by the wilt disease.

Symptoms

The symptoms of wilt on the banana vary with the age and vigor of the plant. On the Latundan the disease may be recognized by the yellowing of the foliage starting from the margins of the older leaves. The yellowing works towards the midrib following the veins. Browning begins from the yellowed part of the leaves. As soon as the bright green color of the leaf disappears the blade droops. All the older leaves may remain apparently healthy for some time. The foliage produced after the plant has shown symptoms of infection may show the tendency to bunch together at the upper end of the pseudo-stem. These symptoms are also shown by the infected abacá seedlings (fig. 1, b, c, d). The fruit may appear and it may either mature normally or remain thin and poorly filled, and ripen prematurely, depending upon the vigor of the plant when infected. If an infected plant produces fruit of normal size, the peduncle often breaks under the weight of the fruit.

A characteristic symptom of the wilt disease as shown by the Latundan banana is the splitting of the pseudo-stem starting from the base and often extending to the portion where the leaf sheaths and the petioles meet. In some instances the entire inner cylinder may come out of the broken outer leaf sheaths. In this case the leaves become smaller and shorter.

The most reliable symptom of wilt infection is the reddish brown or violet color in the region of the vascular bundles in the leaf sheaths and in the corm. These colored tissues are easily seen when the pseudo-stem or the corm is cut. The color is most conspicuous on the outer, older sheaths corresponding to the leaves which show the yellowing of the margin and wilting or drooping of the blades. The central younger leaf sheaths are usually free from the colored bundles except in a very advanced stage of the disease, or in a very serious infection. The reddish brown color starts from the corm and works upwards following the bundles. If an infected plant fruits the colored bundles may be traced up to less than 75 cm. below the peduncle.

All suckers produced by the affected Latundan bananas invariably become wilted sooner or later.

Abacá plants infected by *Fusarium cubense* as a result of planting the seedlings in infected soil, or soil which has been artificially inoculated with pure culture of the organism, do not show all of the symptoms exhibited by the Latundan banana. The tendency of the leaves to bunch up, however, is as evident on the abacá as it is on the banana. The coloring in the bundles of the corm (fig. 2) is as distinct as in the banana and it is also the most reliable symptom of the disease.

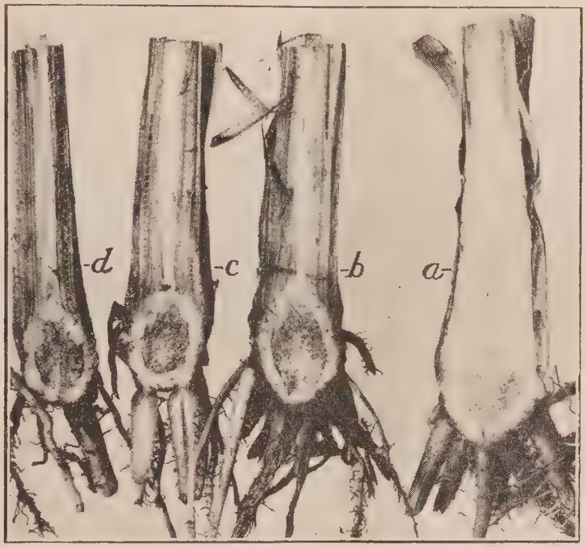

Fig. 2.—Longitudinal sections of pseudo-stems of (*a*) the control and (*b*, *c* and *d*) the inoculated abacá seedlings. Note the dark colored tissues in the corms in (*b*, *c* and *d*) due to *Fusarium cubense* EFS. and compare their appearance with that of the check.

COMPARISON OF PHILIPPINE BANANA-WILT FUNGUS WITH BRANDES' FUSARIUM CUBENSE

Dr. Erwin F. Smith was the first to use the binomial *Fusarium cubense* for the fungus found in banana specimens sent to him from Cuba in 1910. Brandes (1919) reports that the fungus associated with banana wilt was described by Essed in 1911 as *Ustiliginoidea musaeperda* and in 1912 by Drost as *Leptospora musae*. Reinking (1926) found that *Fusarium cubense* is the only fungus associated with typical cases of banana wilt. This author further found that *F. cubense* can produce the typical banana wilt disease in artificial inoculation. Reinking (1926) also showed that *F. cubense* is present in the soil and from this it infects bananas and produces the wilt disease.

According to Brandes the sporodochia produced on leaf stalks and leaf blades of banana by *F. cubense* are hyaline and they arise from the pseudoparenchymatous substratum in the cavities under the stomata.

Mycelium

Like the Central American fungus the mycelium of the Philippine organism is intravascular. Mycelial threads are almost always found in sections of the corm, pseudo-stem, and leaf sheaths which show the browned vascular regions. They occupy mostly the lumen of the xylem vessels and sometimes the other cells of the xylem strand. However, in advanced cases of infection the hyphae may invade the parenchymatous cells around the bundle sheath. The mycelium in the xylem portion is granular, mostly straight and of nearly uniform diameter like the mycelium described by Brandes for the Central American fungus. In serious cases of infection spores may be produced within the xylem.

In culture the hyphal threads are generally wider than those found in the affected banana tissues. The hyphae are typically straight and seldom constricted at the septa. The septa are spaced at moderate intervals. In the formation of sclerotia the hyphae intertwine and form a pseudoparenchymatous layer of short, barrel-shaped cells. The cells beneath the sporodochium are closely-septate and interlaced.

Conidiophores

Brandes (1919) states that the conidiophores of *F. cubense* found on leaf stalks and leaf blades of banana are hyaline, septate, branched and $70 \times 4\mu$ with pointed ends. The branches are arranged in whorls of three, non-septate and they are produced from the upper ends of cells of the conidiophores. The ends of the branches taper abruptly to a point.

The conidiophores of the Philippines fungus is very similar to that of Brandes' *F. cubense*. The average measurement is $72 \times 4.5\mu$ or $2 \times 0.5\mu$, larger than the Central American fungus. The conidiophores were found to be formed within 14 hours in agar culture. They are also non-septate and taper at the tip.

Microconidia

The microconidia are hyaline, oval, or elongate, either one-celled, two-celled or three-celled and $5.0\text{-}7.0 \times 2.5\text{-}3.0\mu$. Transition forms between micro- and macroconidia consisting of straight or curved 0-, 1- and 2-septate conidia are numerous in culture.

The microconidia of the Philippine banana-wilt fungus are 0- to 2-septate, $5\text{-}9 \times 2.4\text{-}4\mu$, hyaline, and oval. Abortive forms similar to those described by Brandes were produced in culture. The septate microconidia are 28.38 per cent of the total number of spores measured and have an average size of 7.41×3.43μ. The average size of the 1-septate microconidia which constitutes 2.42 per cent, is 9.17×3.69μ. The 2-septate microconidia are very rare. A non-septate microconidium germinates by sending a germ tube from any part of the cell.

Macroconidia

Brandes states that the macroconidia of *Fusarium cubense* are of the *elegans* type, four- to six-celled, sickle-shaped, with a pedicel at the basal end. The majority of the macroconidia are four-celled, while a few are five- to six-celled, sickle-shaped, with a pedicel at the basal end. The macroconidia are 22-36×4-5μ. They are borne at the apex of the conidiophores and of their branches.

The macroconidia of the Philippine banana-wilt fungus are 22.2-38.8×3.6-5.2μ, 3- to 5-septate, sickle-shaped and pedicellate. A few pedicellate 1- to 2-septate sickle-shaped conidia over 10 microns in length have been regarded by the writer to belong to this type. More than 46.7 per cent are 3-septate, with an average size of 28.6×3.91μ. The 4-septate macroconidia are 32.1×3.94μ and they constitute 19.74 per cent of the total number of conidia measured. A few of the 5-septate conidia which form 2.6 per cent have an average size of 38.8×4.14μ.

The macroconidia germinate within seven hours in sterile water or in potato agar medium. Before the macroconidia germinate they swell and constrict at the septa. Then germ tubes are sent out either at both ends or from all segments.

The average length and width of the conidia of *Fusarium cubense* of the Philippine banana-wilt falls therefore within the range given by Brandes.

Brandes describes the chlamydospores of *Fusarium cubense* as ellipsoidal to globose, terminal, intercalary, or conidial, single, paired, or in chains. When the chlamydospores are one-celled they are 5.5-6.0×6.0-7.0μ. The writer's measurements of the chlamydospores from the pionnotes of the Philippine banana-wilt are 4.55×8.26μ.

On August 12, 1927, transfers from the pionnotes of agar medium were made on steamed rice in 750 cc. wide-mouthed Erlenmeyer flasks. The fungus grew luxuriantly and it was of a light purplish vinaceous to light vinaceous lilac color.[2] Droplets of moisture collected on the sides of the flasks. A peculiar odor was emitted by the cultures on steamed rice. According to Dr. M. L. Roxas, who was, at the time the experiment was carried on, Professor and Head of the Department of Agricultural Chemistry of the College of Agriculture, the odor produced is like that of formaldehyde but similar to that of benzaldehyde. Brandes states that the odor of the culture is very similar to formaldehyde and that the fungus growth is vinaceous in color.

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[2] The color nomenclature followed is after Ridgway, Robert. 1912. Color standards and color nomenclature. 43 pp., 53 col. pl. Washington, D. C.

On potato-dextrose agar slants the Philippine banana wilt fungus produced abundant submerged and aërial hyphae. The mycelium, white at first, becomes pale lobelia violet or Hyssop violet. On this medium, hard, indigo blue sclerotia similar to those found by Brandes on potato plugs were produced on the lower surface of the slant. These sclerotia ranged from 1 to 3 mm. in diameter and they developed within 20 to 25 days on potato-dextrose agar slants.

On corn-beef agar[3] the growth was luxuriant, the mycelium being aërial and submerged, and whitish. Normal macrospores were obtained from numerous sporodochia produced on the surface of the slant within 14 days. These sporodochia ranged from one mm. to about four mm. in diameter and differed slightly in color from those described by Brandes. The Philippine fungus produced capuchine buff sporodochia. Brandes' Central American organism produced salmon color sporodochia on steamed stems of *Melilotus alba*.

On corn meal agar and oatmeal agar the mycelium penetrated deeply into the medium and less aërial growth was produced. The growth was dark naphthalene violet in an old culture on corn meal agar and lilac to indigo violet on oatmeal agar.

The writer noted that the Philippine banana-wilt *Fusarium* produces at first whitish mycelial growth on all agar media tested. With age, the color of the growth deepened. Old cultures took either vinaceous, violet, lilac or purple tinges. The microconidia were more abundant than the macroconidia in cultures that did not develop sporodochia or pionnotes. On steamed rice Brandes noted a similar deepening of the color of the culture of the Central American fungus from Hermosa pink to vinaceous or violet purple tinges. It seems from these studies that there is no marked difference in cultural characters between Brandes' *Fusarium cubense* and the Philippine banana-wilt fungus.

INFECTION EXPERIMENTS OF ABACÁ SEEDLINGS WITH FUSARIUM CUBENSE

As the banana-wilt fungus *F. cubense* is a soil-borne organism it seems to be spread from field to field by man and animals in the soil which adheres to the tools and feet. The organism is commonly spread when infected plants are carried from one place to another. The fungus seems to gain entrance into the host through injuries in the corms and roots.

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[3] Corn-beef agar was prepared by cooking 50 grams of corn meal with 1000 cc. of nutrient broth and then adding 20 grams of agar to the filtrate after straining the mixture through fine meshed cheese cloth.

Inoculation of the soil with pure culture of Fusarium cubense

Experiment 1. The soil used in this experiment was taken from an old compost pit at the College of Agriculture. The soil was sifted so as to eliminate the coarser particles and then sterilized in a galvanized iron pan for one and one-half hours. During sterilization it was moistened with water to prevent burning the organic matter. At intervals of 15 to 20 minute- the soil was turned over with a spade to insure complete and uniform sterilization. After sterilization it was placed in clean and sterilized 26-cm. pots and allowed to cool.

On April 5, 1927, seedlings of abacá varieties Inusa and Sinibuyas which were about 57 days old were transplanted to 15 pots of the sterile soil, three seedlings to each pot. On July 29, fourteen suckers of Latundan banana which were free from wilt infection, as shown by absence of the red color in the vascular bundles in the corms, were planted in pots of sterile soil. Latundan banana suckers were used for comparing the results because this variety is the most susceptible to wilt.

On September 9, the abacá seedlings and banana suckers were removed from the pots and the soil was poured on a clean cement floor and thoroughly mixed. Six of the pots were refilled with the mixed soil and these were used as control. To the rest of the soil, twelve 750 cc. Erlenmeyer flasks of 27-day-old cultures of *Fusarium cubense* on steamed rice were added and thoroughly mixed.

Abacá seedlings of uniform size were planted in the inoculated and check pots of soil. Three of the six check pots were planted to suckers of Latundan and three to abacá seedlings. Twelve pots of inoculated soil were each planted to two abacá seedlings and the rest to suckers of Latundan. To reduce the loss of water by transpiration before the roots were well established, the greater part of the leaves of the abacá seedlings and banana suckers were cut off before planting. The roots were removed and the corms of the banana suckers and abacá seedlings in both control and inoculated pots were wounded before they were planted. The inoculated and check abacá and banana were kept inside the moist chamber for three days and finally, on September 17, they were placed out of doors.

Observations were made at frequent intervals. It was noted that the check seedlings were vigorous and their leaves were dark green while the inoculated plants were sickly in appearance.

On October 2, one of the abacá seedlings in the inoculated soil wilted. The new leaves of the banana suckers in the inoculated soil were yellowish, shorter, and narrower than the leaves of the control plants. About the middle of October, or approximately 36 days after inoculation, the leaves of both the abacá seedlings and banana suckers began to bunch up. The leaves of the banana plants in the inoculated pots continued to dry up, while those of the abacá seedlings were narrow, yellowish, and the margins seemed slightly wrinkled (fig. 1, *b*, *c* and *d*).

On November 29, the inoculated and uninoculated plants were examined for infection by the disease. All the stems of the inoculated and check plants were cut at the base and the corms were opened longitudinally. The appearance of the disease in the inoculated pots was marked on both the banana and abacá seedlings. In the check plants, not one showed the diseased bundles in the corm. The corms of the inoculated and control plants were washed off and examined for the possible entrance of the disease. It was noted that the organism gained entrance through the cut ends of the roots. In the roots of the control plants no dark red or violet color could be seen in the vascular bundles.

Portions of the discolored tissue of the corms of the inoculated banana and abacá and of the control seedlings were plated out on corn meal on November 30. On the following day a little growth of mycelium was noted on the plates planted to the inoculated abacá and banana corms while on the plates of the control plants no growth was produced. On December 12, it was found that the organism on the plates was *Fusarium cubense.*

Of the 12 plates used in the isolation from portions of the corms of the inoculated abacá and banana seedlings only one plate of the abacá isolation showed no growth. The checks were all free from the fungus.

Experiment 2. The soil infected with pure culture of *Fusarium* used in experiment 1 was replanted to seedlings of abacá variety Inusa, which were 181 days old. Portions of the leaves were cut off to reduce transpiration and the roots were also cut off to open an avenue for the entrance of the fungus.

On November 29, one abacá seedling was planted to each of the 29 pots of both the control and inoculated soil. The pots were kept inside the laboratory until December 5, when the inoculated and check plants were placed under shade out of doors.

The inoculated and control plants did not show any marked difference until January 20, 1928, about 71 days after inoculation. Two of the plants of the inoculated soil showed wilting. At the end of February, one of the abacá seedlings which wilted was dug up. Microscopic examination showed that the hyphae of *Fusarium cubense* plugged the fibro-vascular bundles.

On March 2 four of the wilted abacá plants in the inoculated pots and two of the check plants were dug up. The inoculated (fig. 1*b*, *c* and *d*) and control abacá seedlings (fig. 1*a*) were dissected longitudinally (fig. 2*b*, *c* and *e*). The reddish color was abundant showing the presence of *Fusarium cubense* in the vascular bundles of the abacá seedlings grown in the infected soil. Cross and longitudinal sections of the roots of both the control and the inoculated plants were also made. It was noted that in the seedlings planted in infected soil the organism gained entrance through the cut ends of the roots.

Inoculation of abacá seedlings with normal spores of Fusarium cubense

Experiment 1. Lee and Serrano (1923) report that a fungus similar to, if not identical with, *Fusarium cubense* is the cause of abacá heart rot. Teodoro (1926) and Teodoro and Serrano (1926) also draw the same conclusion. Transfers of *Fusarium cubense* from steamed rice to potato-dextrose agar were made. After eleven days pionnotes were produced.

Twenty-four eight-month-old abacá seedlings, two in each pot of sterilized soil, were inoculated with spores. A suspension of spores in sterile water was prepared and was introduced at the base of the petioles of very young leaves and at the opening of the unfurled leaves. For control the same procedure was used except that sterile water was used in four pots of abacá seedlings instead of spore suspension. This inoculation was made to determine if rotting of the bases of the youngest leaves like the incipient stages of heart rot could be produced.

The abacá seedlings were placed inside the moist chamber for about five days and then were placed outside in the shade.

From the time the abacá seedlings were inoculated, September 19, 1927, to December 14, 1927, or about 75 days, no symptoms of infection could be detected on the inoculated plants; they were as healthy as the control abacá seedlings.

Experiment 2. A second set of this experiment was conducted about the end of June, 1928. Fifteen pots of uniform abacá seedlings about 180 days old, two seedlings in each pot of sterile soil, were inoculated. For control, five pots of the seedlings were used.

About the middle of August, a little over 45 days after inoculation, when examinations were made no symptoms could be noted. The experiment was repeated in September and October, but the results were also negative. Further inoculations made in September, 1929, showed that the spores of *Fusarium cubense* suspended in water and poured into the opening at the base of the petioles of very young leaves and at the openings of the unfurled leaves could not cause infection similar to the incipient stages of heart rot.

Inoculation through pricks in the pseudo-stem

Experiment 1. Thirty abacá seedlings about five months old were planted in pots of sterile soil, two in each pot. They were allowed to grow normally before they were inoculated.

On January 7, 1928, the pots were taken into the laboratory. Ten of the pots of abacá seedlings were inoculated by pricking the pseudo-stem. The rest of the seedlings were pricked but were not inoculated. These were used for control.

A two week-old culture of *Fusarium cubense* on slants of potato-dextrose agar was used for inoculation in experiment 1. The abacá pseudo-stems were pricked with a sterile spear-shaped needle. The pionnotes of the fungus were smeared on the surface of the pricked stems by means of a sterile scalpel. For control five pots of other abacá seedlings were used. The stems were also pricked with a sterile spear-shaped needle. Instead of the fungus being used for inoculation, sterile potato-dextrose agar was used. This medium was smeared on with a sterile scalpel in the same manner as with the inoculated plants. The inoculated and check plants were kept in the moist chamber for about three days. On January 10 they were taken outside of the laboratory for further observation.

The inoculated abacá plants showed loss of turgescence of the leaves in the moist chamber, while the control plants were normal in appearance. When taken outside, yellowing of the leaves was noted after three weeks. The leaves of the control plants were all dark green in color.

Great differences between the inoculated and control abacá seedlings was observed on March 3, about seven weeks after the plants were taken outside. The inoculated abacá plants were stunted in growth, the leaves that came out were slender and became yellow, while the control grew vigorously.

Experiment 2. The same experiment was repeated in the middle of February, 1928. Thirty-six abacá seedlings of nearly the same size regardless of age or variety were used in the experiment.

The results obtained were the same as that in experiment 1, except that being performed during February the work was caught by the hottest part of the year, so that even though the plants were watered daily, both the control and inoculated abacá plants suffered very severely from the heat. The leaves of the control plants turned yellow. The differences noted were that the control plants were much larger, although the leaves turned yellowish, than the inoculated abacá plants which were small and sickly.

Inoculation by planting in naturally infected soil

Experiment 1. The soil used in this experiment was taken on October 20, 1927, from Lalakay, Los Baños, Laguna. The soil was scraped from around the bases of wilt-infected banana plants. It was clay loam with a little admixture of adobe-rock. The soil was thoroughly mixed in the laboratory and part of it was sterilized on an iron pan for two hours. Both the sterilized and the unsterilized soil was placed in 26-cm. pots.

Uniform four-month and 26-day old abacá seedlings of variety Inusa grown from seed, and Latundan suckers were planted in the pots on October 24, 1927.

Fifteen pots of sick soil were used for planting. Four of these pots were planted each to one Latundan sucker, and eleven of them to two abacá seedlings each. Of the eight pots of sterilized sick soil for the control four were planted to Latundan suckers and four to abacá seedlings.

The pots were placed under shade outside the laboratory for observation. On November 17, the writer noted yellowing of the leaves of the banana suckers planted in the sick soil. The control plants were very much more vigorous than the plants in the sick soil. The diseased condition was very conspicuous on December 7, about 43 days after inoculation. The leaves of one of the inoculated banana suckers dried up. The abacá and banana seedlings planted in the sick soil were generally much poorer and more stunted in appearance than the control.

On January 14, 1928, one of the inoculated bananas died, and the rest were sickly in appearance. The abacá seedlings grown in sick soil did not seem to thrive well.

On January 19, one of the sickly inoculated abacá seedlings was dug up, its stem cut off and the corm cut longitudinally. There was no indication of violet or reddish color of the corms. In one of the roots, however, there was reddish color in the vascular regions. Portions of this reddish part of the root were plated on potato dextrose agar. It was found upon isolation that *Fusarium cubense* was present in the roots.

Two of the Latundan suckers and four of the abacá seedlings in the sick soil were then dug up for examination. The corms were cut longitudinally and, with one exception, the corms of the abacá seedlings were found free from wilt disease fungus.

On March 11, the rest of the inoculated abacá seedlings were dug up. Out of the 16 corms cut, 14 showed infection and had dark discoloration of the corms.

The presence of *Fusarium cubense* in one of the roots of abacá seedlings that was dug up from the pots of sick soil seems to show that it takes the organism time to gain entrance through the roots.

Experiment 2. The soil used in this experiment was taken from Lalakay, Los Baños, on November 3, 1927. The soil was thoroughly mixed and placed in 26-cm. pots. Five pots of the sick soil were sterilized in the autoclave for one and one-half hours at 15-pounds' pressure. On November 29, 24 of the pots of sick soil were planted each to one six-months-old abacá seedling of variety Inusa. The roots and the leaves of the seedlings were cut off. Seedlings were planted in five pots of sterilized soil for check on November 30.

The inoculated and control pots were kept in the laboratory for four days and, on December 5, were placed out of doors in the shade.

After two weeks or a little more, some of the seedlings were sickly in appearance. The new leaves began to bunch and the outer sheaths dried up. The control abacá plants were apparently healthy. On January 2, 1928, there was a marked difference between the plants in the sick soil and the control plants. The control plants were growing vigorously. Some of the abacá seedlings in the pots of unsterilized sick soil became yellowish and the leaves bunched up and the others nearly died because of the drying of the outer leaf sheaths.

On January 19, one of the sickly seedlings was dug up. This was examined for the disease. The organism was present in a small portion of the corm. Some more of the seedlings which showed wilting of the leaves were dug up. Out of the four plants that showed the wilting of the leaves three proved to be infected, and one seemed to have no infection. The plants grown in sterile soil were very much better than those in sick soil.

On February 2, the rest of the inoculated and control abacá plants were transferred from the pots to the field for further observations. The inoculated abacá plants regained vigor although the control plants grew much better and appeared very healthy. This seems to be in accord with the results of Ocfemia's experiments and the observations on introduced abacá in Panama. Mr. J. H. Permar of the Research Department of the United Fruit Company, Panama Division, Almirante, R. P., in a letter to G. O. Ocfemia under date of November 27, 1929, stated:

> My brief experience leads me to believe that all the abacá varieties growing here are to some degree susceptible to the wilt disease. Buñgulanon, as stated by Mr. Edwards and Dr. Reinking, is so far the most susceptible.
>
> Plantings established from portions of rhizomes from old mats are most susceptible in the early stages of growth,—that is, during the first six or even twelve months. After twelve months, affected mats improve and by the time the planting is mature scarcely any sign of disease can be noted except by making a most careful inspection.
>
> With the single exception of infrequent mats of a Lono seedling, all affected plants have apparently completely outgrown the disease.
>
> During the past two years I have grown numerous seedlings. Some disease has been noted in all varieties. If the seedling is affected at so early a stage that no followers (suckers) have been produced it frequently dies; but, if followers are growing, the chances are very good that the plant will survive even though the parent stalk may die,—in fact I have suffered no losses to date from such cases. Many seedling plants that were noticeably affected four months ago look perfectly healthy today.
>
> Since I have been interested in abacá, it has always been surprising to me that wilt was never reported from the Philippines. I cannot but feel confident that you will find it in a young planting in any of your areas in which bananas are subject to wilt.

Doctor Ocfemia is of the opinion that the reason that wilt has never been reported on abacá from the Philippine Islands is the fact that the plant usually out-grows infection. In his experiments he found that many of the fast growing abacá plants out-grew the wilt disease.

On March 29, 1928, some of the inoculated plants clearly showed symptoms of the wilt. The leaves that came out were very much narrower than the leaves of normal plants and the foliage produced bunched up at the upper end of the pseudo-stem. Yellowing of the leaves was evident. These leaves eventually became brown and finally drooped downward. Those that showed the symptoms of the wilt were dug up and examined. The corms were cut longitudinally. It was found that *Fusarium cubense* was present in the vascular bundles.

Experiment 3. Sick soil obtained from Lalakay, Los Baños, was mixed thoroughly and placed in 26-cm. earthen pots. Ten pots were sterilized in the autoclave at 15-pounds' pressure for one and one-half hours.

Twenty pots of sick soil with decaying roots and the sterilized sick soil were planted each to three 3-month and 3-day old abacá seedlings of variety Sinibuyas. Uniform abacá seedlings were used for planting.

The plants were kept inside the laboratory for five days, and later on taken outside. The inoculated and the control plants suffered during the heat of July, 1928, so that little difference between the inoculated and checks was observed. However, yellowing and drying of the leaves of the abacá plants in the sick soil was very noticeable. About the middle of August, great changes were noted. The leaves of the control abacá were large and green while the inoculated plants bunched up. Some of the leaves were wrinkled. The growth in general showed that abacá plants in sterile soil are very much more vigorous than those planted in sick soil. Those in sick soil were stunted and sickly in appearance.

CONCLUSIONS

The results obtained in the present work lead to the conclusions that the fungus causing the wilt disease of banana in the Philippines is identical with *Fusarium cubense* EFS. The fungus is capable of infecting abacá seedlings through injuries of the corm and pseudo-stem but not through uninjured portions at the bases of the petioles of very young leaves and unfurled foliage.

The symptoms produced on the abacá seedlings are yellowing of the foliage, bunching of the leaves, stunting of the plants, and coloration of the vascular bundles. The external indications of wilt infection are noticeable from one to three months after inoculation. No splitting of the pseudostem of abacá has been observed thus far.

In the present work not a single case of heart-rot developed in the seedlings inoculated with pure culture in the soil or planted in infected soil. Neither did heart rot develop on seedlings inoculated at the bases of unfurled young leaves.

SUMMARY

1. The fungus that causes banana wilt in the Philippines is identical with *Fusarium cubense.*

2. The symptoms exhibited by the disease on Latundan banana are not all produced in abacá seedlings. However, the loss of turgescence, bunching up, yellowing of the leaves, and coloring of the corms are evident on abacá seedlings.

3. The fungus used in the present study was isolated from banana plants which were infected with banana wilt.

4. Infection of both abacá and banana seedlings may be obtained by growing them in previously sterilized soil inoculated with pure culture of the fungus, *Fusarium cubense*, and in the sick soil.

5. Infection by *Fusarium cubense* of abacá seedlings may be obtained by means of normal spores through artificial injuries on the pseudo-stem. Normal spores cannot infect the heart of abacá if these are placed on the uninjured unfolded leaves. *Fusarium cubense* attacks seedlings of abacá through injuries of the corms and pseudo-stems. Inoculations on the buds did not cause infection. No rotting of the heart followed infection.

6. The symptoms of banana-wilt on abacá seedlings are bunching and yellowing of the leaves. The most reliable symptoms on abacá is shown only upon cutting the corms. This clearly shows the characteristic coloring of the vascular bundles very similar to that produced by the Latundan when infected with *Fusarium cubense.*

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RELATIVE EFFECTS OF DIFFERENT IRON SALTS UPON GROWTH AND DEVELOPMENT OF YOUNG RICE PLANTS[1]

FELIX G. GINES

INTRODUCTION

The present study deals with the growth and development of young rice plants grown in a standard complete culture solution to which different salts of iron were added separately in different amounts. It deals also with the growth and development of the plants in different salts of iron when used singly. Other phases of study on the mineral salt requirements of the young rice plants have been carried out by various investigators. However, that on the determination of the iron requirement of the plants has not been worked out to any extent. To contribute to the limited knowledge on the subject, the present study was undertaken.

Review of literature

The literature on the influence of iron on plants is quite extensive. But only investigations that are closely related to the present study are included in this report.

It was recognized quite early that there exists a close relationship between iron supply and the formation of chlorophyll. This fact was reported by Gris as early as 1884. And Gile and Carrero (1916) report that young rice plants growing ten days in iron-free culture solutions became chlorotic and had leaves that were beginning to dry at the tips. The newly formed leaves were almost pure white, very thin, and generally withered soon.

Hopkins and Wann (1925) report that the solubility of iron was markedly increased by an increase in acidity of the solution and that the usefulness of iron is lost in alkaline solution. Hoagland (1919) points out that the availability of iron to green plants depends largely upon the form and amount of the iron used and upon the reaction with and concentration of the nutrient solution to which it was added. He points out also that certain forms of iron may be completely precipitated in a relatively short time when the total phosphate content of the solution is high. Livingston (1919) states that ferric phosphate precipitates do not dissolve appreciably but furnish a constant and adequate supply of iron. Gile and Carrero (1916) found that when ferric phosphate was present in the culture solution, addition of soluble phosphates produced chlorosis of rice plants. The ferrous and the ferric phosphates were found by Corson and Bakke (1917) to produce different effects upon different plants.

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It has been found independently by Mazé (1900), Hartwell and Pember (1908), and Ruprecht (1915) that ferrous sulfate is toxic to plants. Jones and Shive (1921) also found that in solution containing ammonium sulfate, ferrous sulfate is very toxic to plants even at an exceedingly low concentration. On the other hand, Gile and Carrero (1916) obtained good growth of rice from culture solutions supplied with this salt of iron and found that an increase of the iron from 0.002 to 0.008 gram per liter produced a corresponding increase in growth of the plants, both in acid and neutral nutrient solutions. And Deuber (1926) obtained well developed soybean plants from culture solutions supplied with this compound at the rate of 13.2333 and 6.116 milligrams of iron as ferrous sulfate per plant, over growing periods of five and four weeks, respectively, and increasing the amount of this iron increased growth up to 8.822 parts per million, the maximum used by the author. Marsh and Shive (1925) obtained the highest yields of soybean plants supplied with this salt at the rate of 19.4 milligrams of iron per liter for three plants, or 6.4 milligrams per plant over a growing period of five weeks.

Gile and Carrero (1916) found ferric tartrate as the best source of iron for young rice plants and that ferric chloride was not a good source of iron. especially when the salt was added to culture solutions in an amount less than 0.009 gram per liter.

Objects of the present study

The objects of this study were: (*a*) to determine the relative effects upon young rice plants of different salts of iron when added in different amounts to complete culture solution; and (*b*) to determine the relative effects of different iron salts when supplied singly to young rice plants.

Place and time of the present study

The experimental work was carried out in the Department of Plant Physiology, College of Agriculture, Los Baños, at irregular intervals, from June, 1925, to June, 1927.

MATERIALS AND METHODS

Seeds and seedlings

The rice seeds used in this study were of a lowland variety (var. Roxas), and were obtained from the Agronomy Department. They were first soaked in tap water for about twenty-four hours, then spread between folds of wet blotting paper for the initial germination.

When the germinating grains had radicles about one centimeter in length, they were placed on paraffined bobbinet which was stretched over the wide mouth of a large glass jar filled with tap water. The jar was kept full by pouring water into it every day. When the shoots were about five centimeters high, uniformly developed seedlings were selected for use in cultures.

The iron compounds employed

Except ferric phosphate ($FePO_4$), the iron salts used were all "Baker Analyzed". These were ferric chloride ($Fe_2Cl_6.12H_2O$); ferric nitrate ($(Fe)(NO_3)_3.9H_2O$); ferrous sulfate ($FeSO_4.7H_2O$); ammonium ferric sulfate ($((NH_4)_2Fe_2(SO_4)_4.24H_2O$); and potassium ferricyanide ($K_3Fe(CN)_6$). The ferric phosphate was prepared according to the procedure described by Livingston (1919).

In a bottle with capacity of two liters, 500 cc. of 0.04 molar solution of KH_2PO_4 were placed. Then, with agitation, a weak solution of ferric nitrate ($(Fe(NO_3)_3$ was added until no more precipitate was produced. According to Livingston, there should thus be formed about 0.02 gram-molecule of $FePO_4$, which remains in suspension for considerable time but eventually settles to the bottom of the bottle.

Distilled water was poured into the bottle until it was nearly full. The mixture was shaken thoroughly and allowed to stand till nearly all the liquid was clear. Without loss of the precipitate, the clear liquid was siphoned off, and then the bottle was again filled with distilled water. A shaking, settling, and decanting process followed; this was repeated several times to wash the $FePO_4$ free from KNO_3 and any excess of $Fe(NO_3)_3$ that was originally added. According to Livingston, the washing was to be considered thorough, when one cc. of the wash-water, evaporated at about 60°C. in a porcelain dish, would show no residue. Now all the precipitate with its water was transferred to a one-liter volumetric flask and distilled water was then added to make a liter. According to Livingston, when shaken thoroughly the suspension thus formed contained approximately 0.02 molar of $FePO_4$, about three grams per liter, or three milligrams per cubic centimeter.

The other iron compounds were each prepared at concentrations of 0.02 and 0.001 molar and deposited in 500 cc. bottles from which, by means of a medicine dropper, the amount of iron solution needed was drawn for use in culture solutions. The amounts of iron salt solutions added to culture solutions are recorded in tables 1 to 17[2]. The iron salts which were employed singly were prepared in concentrations 0.0005, 0.00125, and 0.002 molar.

The concentrations of the iron salts added to the culture solutions and those of the salts used singly were computed as follows:

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[2] Owing to lack of space the tables, nineteen in number, in which full data are recorded, are not here published. They are on file in the Department of Plant Physiology, College of Agriculture.

a. Iron salt 0.02 molar, added to the culture solution by drops. The concentration of an iron salt in the 4-salt culture solution was expressed as parts per million (p.p.m.). One cubic centimeter of an iron salt one molar concentration added to 1,000,000 cc. of the 4-salt solution, was arbitrarily considered as *1 part per million.*

The stock solution of any of the iron salt was 0.02 molar in concentration. One drop of this solution had a volume of 0.02 cc. and when reduced to its equivalent in one molar concentration would have a volume of 0.0004 cc. One drop 0.02 molar (or 0.0004 cc. 1 molar) was added to 60 cc. of the culture solution, so that 1 cc. of culture solution would contain 0.000000667 cc. of iron salt solution and 1,000,000 cc. of the culture solution would contain 6.67 cc. (0.000000667 times 1,000,000) or 6.67 p.p.m. Therefore, the concentration of iron salt in the culture solution when one drop of the iron solution was used was 6.67 p.p.m. The concentrations of the iron salt in the other culture solutions were determined by multiplying 6.67 p.p.m. by the number of drops of iron solution.

b. Iron salt 0.001 molar, added to the culture solution by drops. As in *a*, the concentration of an iron in the 4-salt solution was expressed in term of p.p.m. under the same basis.

The stock solution of any of the iron salt was 0.001 molar in concentration and one drop of this solution had also a volume of 0.02 cc. When reduced to its equivalent in one molar concentration it would have a volume of 0.00002 cc. One drop, or 0.00002 cc. of one molar was added to 60 cc. of culture solution. Then 1 cc. of the culture solution contains 0.00000033 cc. of iron salt one molar in concentration. The concentration of the iron salt in 1,000,000 cc. of the culture solution (or 0.00000033 times 1,000,000 equals 0.33 cc.) would be 0.33 p.p.m. Therefore, one drop of the iron salt in 60 cc. of the culture solution produced a concentration of 0.33 p.p.m. of the iron in the culture medium. The other concentrations were computed relatively.

c. When the iron salts were used singly. Each of the iron salts was originally prepared in 0.02 molar concentration and by subsequent dilutions with distilled water concentrations 0.002, 0.00125, and 0.0005 molar were also prepared.

EXPERIMENTS AND RESULTS

The experiments herein reported were conducted after carrying out some preliminary culture trials and gaining sufficient proficiency in the technic. Hence, the amount of experimental errors was reduced to the minimum. Some of the experiments were conducted simultaneously. There were, however, some culture trials that had to be carried out later and in order to make possible the comparison of data from the different culture trials or sets, control cultures were included. The data are recorded in tables[2] and the time and method of gathering these are described under different headings. The criteria of results employed in this study were the following:

External appearance of plants. The color, growth, and development of the plants were noted from time to time during the course of the experiments and any other apparent change in the appearance of the plants. The final observation was made at the end of each experimental period.

Dry weight (a) of tops, (b) of roots, and (c) of tops and roots. After harvesting the plants from each culture, the tops were severed from the roots. The tops and the roots were dried in an electric oven and separately weighed. The dry weight of tops and of the roots from each culture were taken and later added together; the sum was called the dry weight of the tops and roots.

Other observations. The leaves were counted. Every time the culture solutions were renewed and also at harvest time the leaves of the plants in each culture were counted. But owing to lack of marked variations in number of leaves of the plants in the different cultures, the data obtained under this criterion are not included in this report.

DISCUSSION OF RESULTS

The data obtained from this study are first considered separately according to the iron salts employed. The minimum amount of each of the iron salts that gave a normal growth and development of the young rice plants was selected and, for convenience in reference, is here designated as the *minimum beneficial amount.* The results obtained from the minimum beneficial amounts of the different salts of iron were then finally compared to show the relative nutritive values of the different iron salts when separately added to the complete culture solution.

Influence of iron salts present in culture solution upon young rice plants

Potassium ferricyanide. The culture solutions supplied with more than 40.02 p.p.m. of potassium ferricyanide soon produced plants stunted in growth with leaves dried at tips, and as the amount of the iron in the solution was increased the detrimental effects upon the plants were shown earlier and were more severe. When the iron salt was added to the culture solution at the rate of 33.35 and 40.02 p.p.m, the plants became abnormal only during the latter part of the growth period. On the other hand, those supplied with iron in amounts 1.32 p.p.m. or less soon produced chlorotic leaves and had stunted growth. Chlorotic plants, stunted in growth were also obtained from the 4-salt solution without the iron; indicating that if greening was produced from some of the culture it was due to the kind and amount of iron that had been added to the solution. The plants supplied with from 1.65 to 26.68 p.p.m. of this salt were apparently normal throughout the culture period, and under the different criteria of results here employed, were better than those grown in the rest of the cultures. It is therefore evident that the salt was beneficial to the young rice plants when added to the complete solution in amounts ranging from 1.65 to 26.68 p.p.m. and that the *minimum beneficial amount* that produced plants of normal growth and development was 1.65 p.p.m.

Ferric chloride. The cultures that were supplied with 1.32 to 6.67 p.p.m. of ferric chloride produced rather tall plants with leaves pale green in color, while those that were supplied with 0.99 p.p.m. or less of this salt soon produced chlorotic leaves and stunted growth. The plants grown in the iron-free solution produced chlorotic leaves earlier and were more markedly stunted in growth. However, the cultures that were supplied with 13.34 to 133.4 p.p.m. of ferric chloride produced tall green plants throughout the experimental period and the data under the different criteria of results here employed also show that the plants obtained from these cultures were better developed than those raised from any of the rest of the cultures. Ferric chloride is, therefore, beneficial to the young rice plants and could be used in a very wide range of concentrations in the culture solution, from 13.34 to 133.4 p.p.m. or possibly even more, and that the *minimum beneficial amount* that produced young plants of normal development was 13.34 p.p.m.

Ferric nitrate. The plants that were supplied with ferric nitrate in the culture solution in amounts ranging from 1.32 to 6.67 p.p.m. produced slender plants with leaves pale green in color, while those that received the iron in amounts 0.99 p.p.m. or less produced plants slightly stunted in growth and with chlorotic leaves. However, the cultures that were supplied with ferric nitrate in amounts from 13.34 to 133.4 p.p.m. also produced slender plants but with apparently normal green leaves. The minimum beneficial amount of the iron that produced young rice plants with rather normal growth and development was 13.34 p.p.m. In complete culture solution, ferric nitrate appears to have the tendency to produce rather slender plants, a characteristic probably due to the increase of nitrate in the culture medium.

Ferric phosphate. The cultures to which ferric phosphate was added at the rate of 26.68 p.p.m. produced vigorous plants, but their leaves were quite pale green; while those supplied with amounts 20.01 p.p.m. or less produced stunted plants with chlorotic leaves; and their chlorotic conditions were noticed later than that of the plants grown in the iron-free solution. However, the cultures supplied with the iron at the rate from 33.35 to 133.4 p.p.m. produced vigorous plants with normal green leaves, and other data under the different criteria of results here employed also show that the plants obtained from these cultures were much better developed than those grown in the other solutions. It appears, therefore, that the minimum beneficial amount of this iron that produced young rice plants of normal development was 33.35 p.p.m.

Ammonium ferric sulfate. The cultures supplied with 0.33 p.p.m. produced plants slightly stunted in growth and with chlorotic leaves and the cultures that were supplied with 0.66 p.p.m. had slender plants with pale green leaves. The cultures to which 126.73 and 133.4 p.p.m. were added produced slightly stunted plants with dark green leaves, but their roots were discolored and apparently injured. However, those that received 0.99 to 120.06 p.p.m. gave slender plants with dark green leaves throughout the culture period. At a moderate application, therefore, this iron salt has the tendency to produce slender plants; the minimum beneficial amount was 0.99 p.p.m.

Ferrous sulfate. The culture solutions that were supplied with 0.33 and 0.66 p.p.m. soon produced plants with pale green leaves. During the latter part of the culture period these plants were somewhat stunted in growth and had chlorotic leaves. Chlorotic plants were also obtained when the iron salt was used at the rate of 0.99 p.p.m. The cultures that were supplied with the iron, 1.32 to 133.4 p.p.m. produced slender plants with leaves dark green in color throughout the culture period; the minimum beneficial amount being 1.32 p.p.m. The tendency of this iron salt, when used in certain amounts, to produce rather slender plants was first observed by Mazé (1900), Hartwell and Pember (1908), Ruprecht (1915), and some others who report that ferrous sulfate is toxic to plants.

Concentrations that gave beneficial effects. By compiling the data obtained from the cultures that gave good results, table 1 was built.

TABLE 1

Showing iron salts in concentrations beneficial to the young rice plants

IRON SALT IN COMPLETE CULTURE SOLUTION	MINIMUM BENEFICIAL AMOUNT	RANGE OF BENEFICIAL CONCENTRATIONS	APPEARANCE OF PLANTS AT HARVEST
	p.p.m.	*p.p.m.*	
$K_3Fe(CN)_6$	1.65	1.65 – 26.68	Normally developed
$Fe_2Cl_6 . 12H_2O$	13.34	13.34 –133.40	Normally developed
$Fe(NO_3)_3 . 9H_2O$	13.34	13.34 –133.40	Plants slender; leaves green
$FePO_4$	33.35	33.35 –133.40	Normally developed
$(NH_4)_2Fe_2(SO_4)_4 . 24H_2O$	0.99	0.99 –120.06	Plants slender; leaves dark green
$FeSO_4 . 7H_2O$	1.32	1.32 –133.40	Plants slender; leaves dark green

From the data in table 1 it appears that (except potassium ferricyanide and ammonium ferric sulfate) the amounts of the iron salts that gave beneficial effects upon the plants had quite a wide range. The data suggest that amounts higher than 133.40 p.p.m. (the maximum amount used) of the ferric phosphate, and of the ferrous sulfate, may produce good results also. In the beneficial amounts, potassium ferricyanide, ferric chloride, and ferric phosphate produced normal plants, while the rest of the salt used tended to produce slender plants.

Percentage of relative efficiency of the iron salts used. Taking the sum of the dry weights of tops and roots of five consecutive plants that were supplied with beneficial amounts (from the plants supplied with *minimum beneficial amount* inclusive) we have 1240 for potassium ferricyanide; 1469 for ferric chloride; 1171 for ferric nitrate; 1517 for ferric phosphate; 980 for ammonium ferric sulfate; and 993 for ferrous sulfate. Considering these figures as a rough basis for comparing the relative efficiency of the salts and making ferric phosphate as the standard, or 100, we have the following:

Potassium ferricyanide	82
Ferric chloride	97
Ferric nitrate	77
Ferric phosphate	100
Ammonium ferric sulfate	64
Ferrous sulfate	65

It is now plainly shown that potassium ferricyanide is 18 points inferior to ferric phosphate; to ferric chloride, 3 points; to ferric nitrate, 23 points; to ferric ammonium ferric sulfate, 36 points; and ferrous sulfate is 35 points inferior to ferric phosphate in the production of dry weight. But it is interesting to note that at higher concentrations, as around 13.34 p.p.m., potassium ferricyanide produced plants with dry weights markedly heavier than any of the plants in any of the cultures supplied with any of the other iron salts, and the cultures supplied with ferric chloride, at amounts equal to the amounts of ferric phosphate added to corresponding cultures, produced heavier dry weights than those of the corresponding plants in the ferric phosphate.

Influence of iron salts fed singly to young rice plants. One might expect that the plants grown in the single salt solutions would be poor, for the reason that the elements essential for the normal growth and development of plants were not all present in each of the solutions. The plants in each of the iron salt solutions were all very poor. The degree of the effects of the salts used varied according to the kind of the iron salt employed and the concentration of the solutions used. As was expected, the plants grown in Espino's best culture solution gave normal plants in all respects throughout the culture period, and the cultures supplied with distilled water produced markedly stunted plants with extremely chlorotic leaves.

Except the ferric phosphate, it was found that the deleterious effects of each of the iron salts used upon young rice plants were directly proportional to the concentrations of the solution employed. In any of the concentrations used, the ferric phosphate produced plants of practically the same stand, growth, and development, and better than any of those grown in any of the other iron salt solutions. The fact that the ferric phosphate produced plants of practically the same stand or growth and development may be attributed to the physical characteristic of the precipitate. The ferric phosphate precipitate did not dissolve appreciably as was reported by Livingston (1919), so that the actual concentration of the ferric phosphate solution was lower than the theoretical one in each of the corresponding concentrations here employed.

Except the ferric phosphate, it has been found that at 0.0005 molar the potassium ferricyanide, ammonium ferric sulfate, ferric chloride, ferrous sulfate, and ferric nitrate, were in the order named detrimental to the growth and development of young rice plants. But at 0.00125 and 0.002 molars, ferric nitrate produced more injurious effects upon the seedlings than the ferrous sulfate, and the rest of the iron salts were deleterious to the plants in the same order as mentioned above under all the criteria of results here employed.

SUMMARY AND CONCLUSIONS

1. All the six iron salts here studied seem to have been able to supply iron to the young rice plants when grown in complete culture solution.
2. Ferric nitrate, ammonium ferric sulfate and ferrous sulfate in complete culture medium showed a tendency to produce slender young rice plants.
3. A range of from 13.34 to 133.4 or more p.p.m. of ferric chloride and of ferric nitrate was found beneficial to young rice plants.
4. Probably owing to the fact that the ferric phosphate precipitate did not dissolve appreciably, the *minimum beneficial amount* of ferric phosphate for the plant was rather high, 33.35 p.p.m.
5. The presence in large amount in complete culture solution, each of ferric chloride, ferric nitrate, ferric phosphate, or ferrous sulfate was found not harmful.
6. Only a relatively small amount in complete culture solution, of each of potassium ferricyanide, 1.65 p.p.m.; ammonium ferric sulfate, 0.99 p.p.m.; and ferrous sulfate 1.32 p.p.m., was sufficient to produce green plants.
7. When used singly and at a concentration of 0.0005 molar, potassium ferricyanide, ammonium ferric sulfate, ferric chloride, ferrous sulfate, ferric nitrate, and ferric phosphate, were in the order named toxic to young rice plants. But at 0.00125 and 0.002 molar, ferric nitrate was much more toxic than ferrous sulfate, and the rest were toxic in the same order as named above.
8. The toxicity of the iron salts upon young rice plants was directly proportional to the concentration of the solution used, except the ferric phosphate which did not give a marked increase in toxicity as the concentrations of the solutions were increased.

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MULTIPLICATION OF SELECTED COFFEE TREES IN THE COLLEGE OF AGRICULTURE BY GRAFTING[1]

TARSILO ROMERO

WITH FIVE TEXT FIGURES AND ONE CHART

Multiplication of the coffee plant by seedlings was the only method practiced by the Spanish missionaries who introduced this important beverage plant in the Philippines. Grafting has never been used by the Filipino growers as a method of multiplying desirable coffee trees. So far as the writer knows, there is not a single coffee plantation in the Islands with grafted coffee trees under cultivation. The slow awakening of appreciation of the value of grafting may be due to the fact that seedlings can be produced easily and little selection of mother plants is practiced. It may also be due to lack of knowledge of the merits of grafting and how to perform it. To graft requires skill and experience.

The objects of propagating coffee trees by means of grafting can be grouped under two heads: (*a*) to perpetuate individual characters of good trees; and (*b*) to increase the rate of multiplication.

That grafted trees come "true-to-type" as a rule is indisputable. In other words grafted plants can be depended upon to produce characters which are found in the mother plant. To find the practicability of multiplying selected coffee trees by means of cleft and bark graftings, and of using different kinds of scions and materials for covering the new grafts are the most important points considered in this work.

REVIEW OF PAST WORK

There is comparatively little literature available in the Philippines on the propagation of coffee by cleft and bark graftings, although much work on grafting has been done in Java. Prayer and Zimmerman (1901) found that the best trees for stocks were those not less than three years old; and the graft should be made on the central stem. According to these authors, trees that had grown too high might be cut off about three feet from the ground and the strongest shoot arising from the stump used for the stock. Wester (1922) states that cleft grafting should be employed first in top working seedlings in the plantation, and that all the young growths from the stocks could be cleft grafted or shield budded again. According to his statement the Dutch in Java are quite advanced in the work of grafting coffee. In that country large acreage has been planted to grafted trees. Cramer (1923) found that cleft grafting seedlings in the seed bed or on offshoots of old stumps was a sure and easy process. He did much to encourage the planters in Java to replace undesirable seedling trees with ones that had been grafted. In 1923 this investigator came to the conclusion that the Liberian and Excelsa coffees in Java were the best stocks. His opinion on the age of seedlings used for grafting is here quoted:

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[1] Thesis presented for graduation, 1930, with the degree of Bachelor of Agriculture from the College of Agriculture No. 307; Experiment Station contribution No. 648. Prepared in the Department of Agronomy under the direction of Dr. Nemesio B. Mendiola.

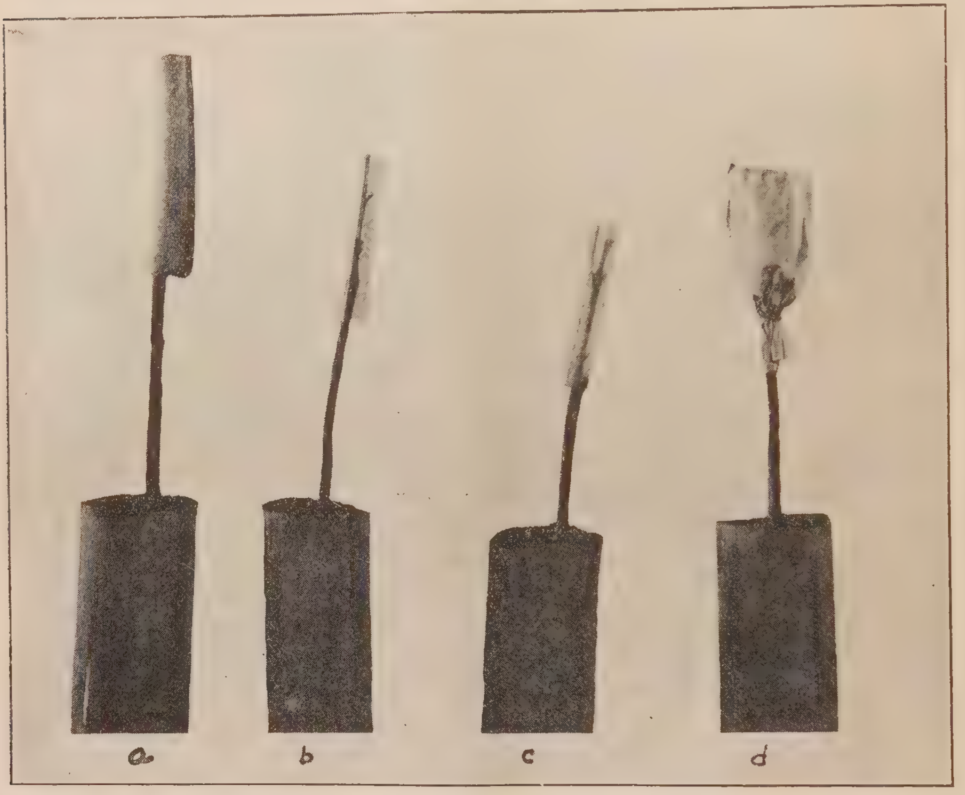

Fig. 1.—Different kinds of protecting material. (*a*) Banana leaf petiole; (*b-c*) glass tubes; (*d*) paper funnel with sphagnum moss.

> If grafting is to be done on a large scale then the necessary measures should be adopted in time: for example, if a large tract of land is to be planted with grafted trees at the end of 1924, then the seed for propagating the stocks should already have been sown in the germinating beds in September, 1923, so that by November of the same year the seedlings can be transplanted in the nursery beds. Then at about the time of the next west monsoon the grafting can take place."

Mendiola (1928) in his agricultural investigations in Java found that the method there used in multiplying selected coffee is as follows: Selected seedlings are grafted on old stocks. These grafts begin to produce after two years. The stock used for grafting is about the thickness of a finger. In case the stumps are grafted, four sprouts are grafted at the same time and later thinned to one. "If a clon in the Museum Garden is selected, 49 grafts are made and planted in another garden. If this clon is exceptionally promising, in addition to the 49 grafts, a hectare of grafts and another of seedlings are planted to it in the hectare gardens.

"The hectare gardens are kept under observation from two to three years, after which time, one is able to tell the true value of a clon. The seeds harvested from desirable clons are for distribution outside. After nine years the value of a clon can be ascertained in less time if it is extraordinarily promising.

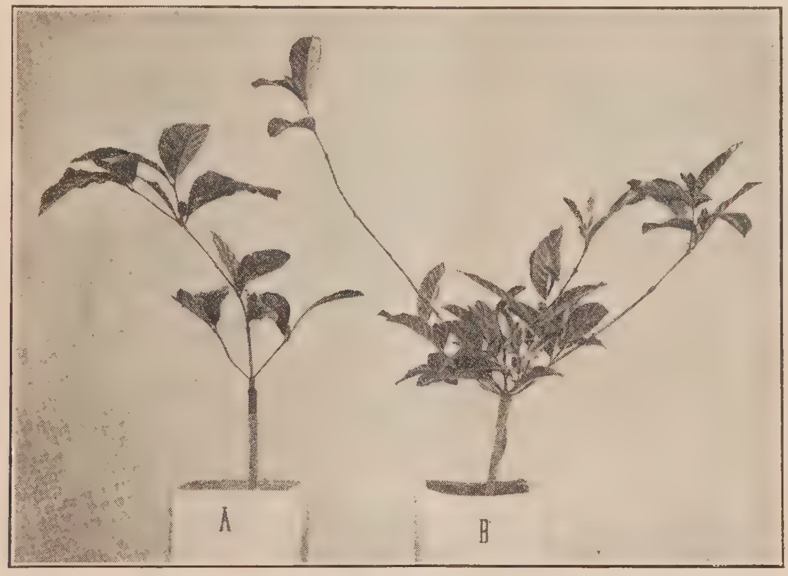

Fig. 2.—Effect of lateral branch as scions. (*A*) Lateral branch with terminal bud; (*B*) lateral branch with terminal but cut off.

OBJECTS AND TIME AND PLACE OF THE EXPERIMENT

The objects of the present work were to determine: (1) the practicability of grafting coffee plants under local conditions, (2) the months favorable for grafting, (3) the stocks suitable for grafting, and (4) the effects of the different materials used in covering the new grafts.

The work was begun in January, 1928, and closed August, 1929, in the coffee nurseries of the College of Agriculture, Laguna.

MATERIALS AND METHODS

Description of materials and equipment

For scions, varieties Robusta, Excelsa, Liberica and Arabica were used. The Robusta variety is planted in the Plateau Coffee Plantations in hectares A, E and F; Excelsa in hectare G, and Liberica in the Experiment Station. Our records on these varieties in the College for the period 1927 to 1929 show the following:

Of over 3,000 trees grown in this College, 100 bearing trees of Robusta variety were used as bases for selection. The average annual yield to a tree of these 100 trees was found to be 2,187.78 grams fresh berries. The 10 highest yielding trees were used as sources of scions. In hectare A, hills 579, 698, 702, 707 and 831, which gave an average yield each year of 4,503, 5,063, 4,736, 4,163 and 4,476 grams fresh berries, respectively, were selected. In hectare E, hills 80 and 280, which gave an average yield each year of 5,777 and 4,186 grams fresh berries, respectively, were selected. In hectare F, hills 373, 440 and 458, which gave an average yield each year of 4,753, 5,700 and 4,120 grams fresh berries, respectively, were selected.

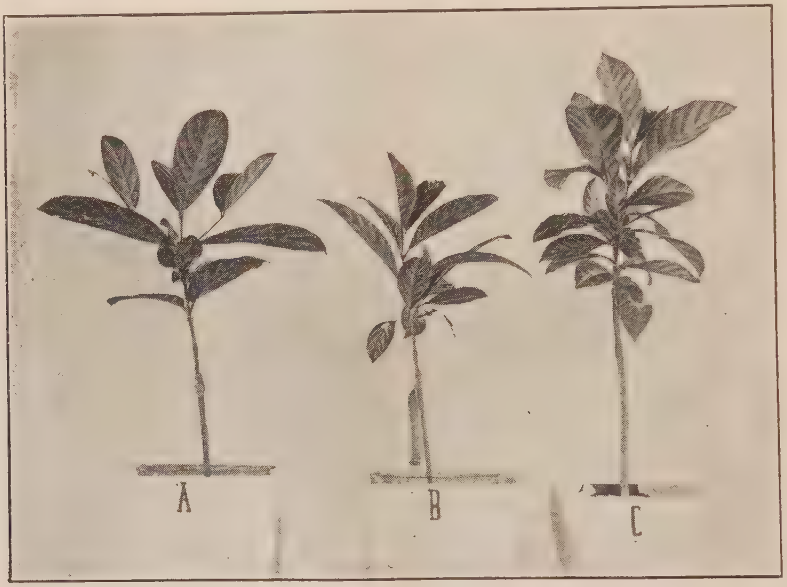

Fig. 3.—Effect of the main stems or vertical growths as scions. (*A*) and (*B*) with terminal buds; (*C*) with terminal bud removed.

The more than 200 Excelsa trees grown in the College gave an average yield each year of 2,572 grams fresh berries. The 10 highest yielding trees of Excelsa were used as sources of scions. These trees are all in hectare G. Trees numbered 2, 12, 13, 16, 25, 28, 29, 31, 55 and 56, which gave an average yield each year of 10,690, 3,285, 3,380, 3,140, 7,240, 3,795, 3,800, 3,540, 3,500 and 5,330 grams fresh berries, respectively were selected. The yield of Liberica trees in the College Plantations had not been determined when this work was begun. The trees were beginning to bear fruit and so the selection of the ten highest yielding trees was based upon their vigor and appearance instead of their actual performance. Likewise, there was no record of yield of the Arabica trees in barrio San Antonio, Los Baños. The selection of Arabica trees was based upon the number of berries observed at the time the scions were obtained.

To secure a constant supply of fresh scions, the selected trees were slightly pruned so as to force the production of water sprouts.

Seedlings of *Coffea quillou* and *Coffea excelsa*, about three years old, were used as stocks in this experiment. The most important reasons for using these varieties as stocks are that they have been found to be adapted to local conditions, as reported by Ramos (1928), and a sufficient number of these seedlings were available for this work in the College nurseries. More seedlings of *Coffea quillou* than of *Coffea excelsa* were used because most of the Excelsa seedlings were too old to serve as stocks. Seedlings were cleft and bark grafted monthly using Excelsa, Robusta, Liberica and Arabica scions. Both lateral branches and the vertical growths of the suckers were used as scions. Too much evaporation of moisture from the new grafts was prevented by covering them with either sphagnum moss, glass tubes, or banana leaf petioles.

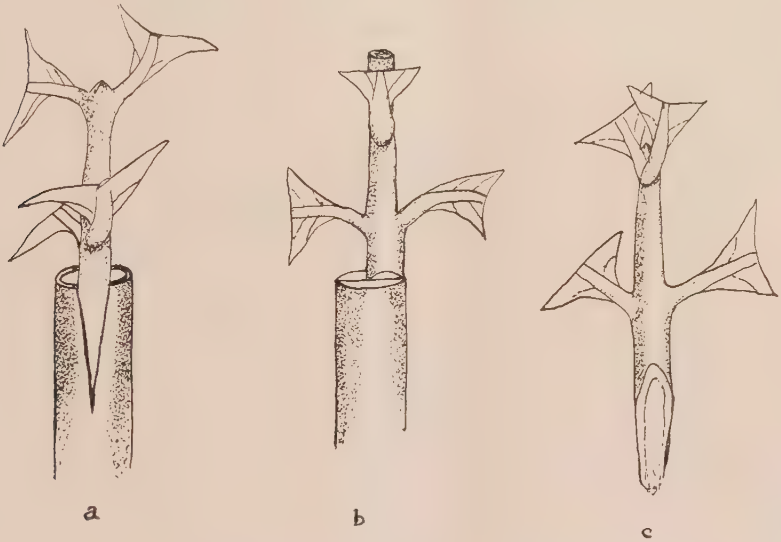

Fig. 4.—Cleft grafting. (*a*) front view; (*b*) side view; (*c*) scion.

The grafting tape used was made of white cotton cloth rolled on a stick to a diameter of about 2.5 cm. and dipped in a melted mixture containing, by weight, one part tallow, two parts resin, and four parts beeswax. The tools used were a sharp knife and a pair of sharp pruning shears.

Plan of the experiment

The seedlings used were in nursery rows 20 cm. apart. Some seedlings were in earthen pots and some in bamboo tubes. The seedlings were in the direct sunlight in the morning and at noon shaded by a trellis partially covered with palm leaves. The seedlings were cut less than 30 cm. from the ground, and then cleft and bark grafted. Stocks in which grafts failed to grow were grafted again after removing the old cut. Sometimes one or two repetitions were necessary before success was obtained.

About forty seedlings were grafted each month. One half were covered with either a glass tube, sphagnum moss, or banana leaf petiole; the other half were left uncovered. Throughout the progress of the experiment only one kind of grafting tape was used. The methods of grafting employed were cleft and bark grafting; the latter was used on stocks that were fairly large.

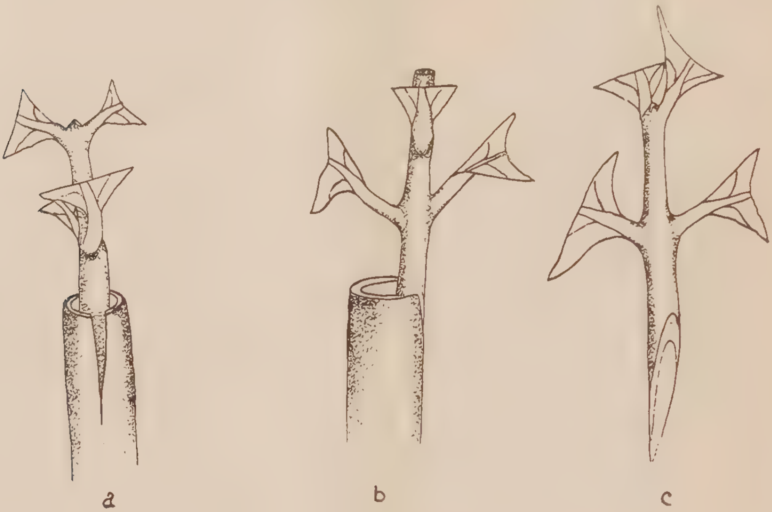

Fig. 5.—Bark grafting. (*a*) front view; (*b*) side view; (*c*) scion.

Cleft grafting. In cleft grafting the scion was cut wedge-shaped; the length of the cut varied from 2.5 to 3.5 cm. The length of the scion, with all leaves removed, varied from 7 to 12 cm. With a pair of pruning shears a stock was cut at a right angle to its axis about 30 cm. from the ground. Later, the cut was made smooth with a sharp knife. With the sharp blade of the knife the cut was opened downward about the length of the wedge, and then the prepared scion was inserted, placing it very carefully so that the two cambium layers, that of the stock and that of the scion, came in contact. In cases where the stock was much larger than the scion the outer edge of the scion was made thicker in order to insure better contact of its cambium layer with the cambium layer of the stock. The wound was tied with twine and then wrapped with the grafting tape. Wrapping was started at the lower end, winding upward until the whole wound was perfectly covered. At the upper end of the wrapping, it was found necessary to press the tape gently against the stem to prevent the entrance of water or the evaporation of moisture from the scion. The glass tube was supported by a stick so that the terminal bud of the scion would not come in contact with it. When a banana leaf petiole was used, a round stick about the same size of the scion was thrust through the center as a guide hole for the scion to pass through. When sphagnum moss was used a piece of manila paper was wrapped around the stem in the form of a funnel, just below the wound. The wet sphagnum moss was placed inside the paper funnel. All covering materials were removed about three weeks after the date of insertion. All the water sprouts arising from the stock were removed.

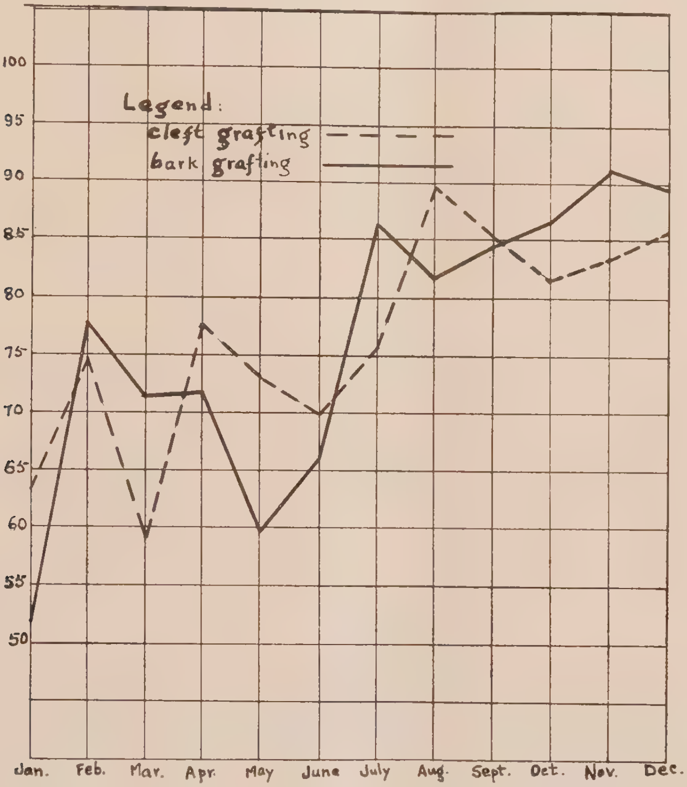

Chart 1.—Graph showing the average percentage of success in bark and cleft graftings.

Bark grafting. The stocks were cut in the same way as in cleft grafting. The length of the scion varied from 7 to 12 cm., depending upon the kinds used. When the vertical growth of the sucker was used, the scion was cut much longer because the nodes were far from each other. The scion used always had at least two internodes. With a sharp knife a slit was made at the center of the cut surface of the stock running downward. The length of the slit depended upon the diagonal cut of the scion. The scion was prepared by removing all the leaves, and about 4 cm. from the lower end of the scion a diagonal cut was made from the upper to the lower end.

The cut was made from one direction only in order to avoid mutilating the tissues. Then the prepared scion was inserted between the wood and the bark, placing the diagonal cut surface against the wood. To insure better contact between the two cambium layers, the diagonal cut was not all inserted. To keep the scion in its position it was tied with twine, then the wound was covered with grafting tape as usual. In all cases either glass tubes, sphagnum moss or banana leaf petioles were used for covering. When sphagnum moss was used a piece of manila paper was wrapped around the stem just below the cut surface, placing the wet sphagnum moss inside the bag thus made around the scion.

EXPERIMENTS AND RESULTS

About 1600 Excelsa, Robusta, Liberica and Arabica scions were grafted on Quillou stock. About 700 scions of the same varieties were grafted on Excelsa stock.

There were two kinds of scions used in this experiment: lateral branches with a terminal bud and vertical growths of suckers with and without a terminal bud.

The results of this work are shown in tables 1 to 8, chart 1, and figures 1 to 5.

DISCUSSION OF RESULTS

The effect of a lateral branch used as a scion is shown in figure 2 (see A). This plant is not expected to become a normal plant inasmuch as the growth is mostly in only one direction and no branches are produced from the main stem. On the other hand, the effect of a lateral branch with a terminal bud cut is shown in figure 2 (see A). This plant is not expected to become a large-sized plant because the branches produced are all lateral and do not grow upward. They are all practically in a horizontal position. The effect of vertical growth or of a main stem with a terminal bud is shown in figure 3. These plants are expected to become normal plants because the terminal bud continues its growth upward, at the same time producing lateral branches.

In all cases two sets of work were carried each month. One set involved grafts with cover, the other set, grafts without cover. The number of grafted Excelsa on Quillou is shown in table 1. The percentage of success varied from month to month and also according to the treatment given to the new grafts. The highest percentage of success was obtained during the months of June, February, and March. Better success was obtained with cleft grafting than with bark grafting.

Table 2 shows the number of grafted Quillou on Excelsa. The percentage of success varied. It can be readily seen that better success was obtained in cleft grafting both with and without cover. With Excelsa as the stock the highest percentage of success was obtained in September and November. The number of grafted Robusta on Quillou is shown in table 3. The highest percentage of success was obtained in July. Both cleft and bark graftings with and without cover gave satisfactory results.

The number of grafted Liberica on Quillou is shown in table 4. The highest percentage of success was obtained in May. The two methods of grafting employed gave practically the same degree of success. The number of grafted Liberica on Excelsa is shown in table 5. Both cleft and bark graftings with and without cover gave practically the same results. The highest percentage of success was obtained in September.

Table 6 shows the number of grafted Arabica on Quillou. The grafting was not continuous because of lack of materials. There were very few plants of Arabica of good yield in barrio San Antonio and none in the College plantings. This variety is very susceptible to attacks of coffee rust. The percentage of success obtained for September was found to be fairly good. The number of grafted Arabica on Excelsa is shown in table 7. The highest percentage of success was obtained in May with banana leaf petioles as covers. During the progress of the experiment many grafted seedlings, especially Robusta, were attacked by the coffee-stem borer.

For the purpose of determining the better method of grafting, the average percentage of success in each month was determined. The average for each method using Quillou and Excelsa as stocks is shown in table 8. The success in the different months is shown graphically in chart 1.

The value of using the right kind of scions in coffee grafting is a very important point to consider in this line of work. The main stem or vertical growth of the suckers with or without terminal buds proved to be the best source of scions, while lateral branches with or without a terminal bud were not good sources. The desirable qualities or merits of scions from these different sources are illustrated in figures 2 and 3. A scion from the main stem or vertical growth of the suckers has the desired qualities in that the terminal bud continues its growth, producing at the same time lateral branches. In other words, it should become a large plant. On the other hand a scion from the lateral branch, with or without a terminal bud, does not have the desired qualities, because the resulting plant can not be expected to grow to a normal tree. The lateral branch as scion with terminal bud does not produce branches; while the main stem or vertical growth of the suckers produces branches. A plant with fewer branches can not be expected to bear as many berries as a plant with a greater number of branches.

For protection from the loss of moisture sphagnum moss and banana leaf petioles proved best during the dry season. In order that the sphagnum moss might not get dry, watering once in a while was necessary. When this was done the scions were better kept before the union of the cambiums took place. When using banana leaf petioles it was found necessary to change them once before union took place. If not changed, the petioles shrank, pressing the scion and causing the death of the graft. Glass tubes proved to be a very efficient cover during the rainy season. To preserve the scions well it was necessary to shade them partially, otherwise the terminal bud of the scion became scorched on sunny days. The newly inserted scions were very delicate so that with glass tubes as protecting material, the grafted plants had to be well shaded.

Table 8 gives the summary of results. The average percentage of success for bark grafting was 74.8 and for cleft grating, 76.6.

As may be seen from chart 1, the highest average percentage of success for bark grafting was obtained during the months of November and December and for cleft grafting during August, September, and December. The stock used in this case was *Coffea excelsa.*

SUMMARY OF CONCLUSIONS

1. Among the protecting materials used, glass tubes proved to be efficient for the rainy season and banana leaf petioles and sphagnum moss for the dry season. In general, covered grafts gave a higher percentage of success than the uncovered.
2. The main stems, or vertical growth of suckers with and without terminal buds, were found desirable sources of scions for grafting coffee.
3. Lateral branches without a terminal bud used as scions for grafting coffee produced plants with spreading habits, with terminal buds the growth was practically all in one direction, and the plant did not produce branches from the main stem.
4. Excelsa was found to be a better stock than Quillou.
5. In this work, 2,297 grafts were made, of which 1,792 were successful. Of the successful grafts, 528 were Robusta on Quillou, 276 were Excelsa on Quillou, 298 were Liberica on Quillou, 218 were Liberica on Excelsa, 135 were Arabica on Quillou, 312 were Quillou on Excelsa, and 25 were Arabica on Excelsa.

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TABLE 1

Number of grafted Excelsa on Quillou

DATE	NUMBER INSERTED		LIVING PLANTS 3 MONTHS AFTER INSERTION		PERCENTAGE OF SUCCESS		COVERING
	Bark	Cleft	Bark	Cleft	Bark	Cleft	
1928							
Jan. 20	—	24	—	20	——	83.3	Glass tube
Jan. 30	36	—	25	—	69.4	——	Not covered
Feb. 4	24	—	20	—	83.3	——	Glass tube
Feb. 16	—	22	—	14	——	63.6	Not covered
March 27	10	—	6	—	60.0	——	Glass tube
March 28	—	32	—	30	——	93.7	Not covered
March 29	—	14	—	10	——	71.4	Glass tube
April 30	13	37	9	33	69.2	89.8	Cleft, with glass tube; bark, not covered
May 15	25	25	18	20	72.0	80.0	Bark, with glass tube; cleft, not covered
June 5	10	30	8	25	80.0	83.3	Cleft grafts with glass tube; bark grafts not covered
1929							
Feb. 9	—	9	—	8	——	89.0	Banana leaf petiole
April 20	12	—	10	—	83.3	——	Banana leaf petiole
April 25	—	10	—	8	——	80.0	Not covered
July 12	5	—	4	—	80.0	——	Not covered
July 13	—	10	—	8	——	80.0	Glass tube
Average...	—	—	—	—	74.6	81.5	

TABLE 2

Number of grafted Quillou on Excelsa

DATE	NUMBER INSERTED		LIVING PLANTS 3 MONTHS AFTER INSERTION		PERCENTAGE OF SUCCESS		COVERING
	Bark	Cleft	Bark	Cleft	Bark	Cleft	
1928							
July 21	22	35	20	30	90.9	85.7	Cleft, not covered; bark, sphagnum moss
July 28	19	—	15	—	78.9	——	Glass tube
July 29	8	—	6	—	75.0	——	Glass tube
Aug. 5	16	5	14	5	87.5	10.0	Glass tube
Aug. 12	4	22	2	21	50.0	95.4	Glass tube
Aug. 13	10	5	9	3	90.0	60.0	Not covered
Sept. 29	—	18	—	16	——	88.8	Not covered
Sept. 30	8	15	7	14	87.4	93.3	Glass tube
Oct. 20	12	18	11	15	91.6	83.3	Banana leaf petiole
Oct. 21	—	20	—	16	——	80.0	Not covered
Nov. 24	—	25	—	22	——	88.0	Glass tube
Nov. 25	16	15	15	13	92.5	86.6	Not covered
Dec. 22	13	20	12	16	92.3	80.0	Not covered
Dec. 22	15	20	13	17	86.6	85.0	Banana leaf petiole
Average...	—	—	—	—	83.9	86.0	

TABLE 3

Number of grafted Robusta on Quillou

DATE	NUMBER INSERTED		LIVING PLANTS 3 MONTHS AFTER INSERTION		PERCENTAGE OF SUCCESS		COVERING
	Bark	Cleft	Bark	Cleft	Bark	Cleft	
1928							
Jan. 25	—	16	—	9	——	56.0	Glass tube
Jan. 27	16	—	7	—	43.0	——	Not covered
Jan. 28	—	18	—	13	——	72.0	Glass tube
Feb. 8	—	25	—	18	——	72.0	Glass tube
Feb. 9	35	—	24	—	68.5	——	Not covered
March 29	33	20	29	10	87.8	50.0	Cleft, with glass tube; bark, not covered
April 25	30	—	26	—	86.6	——	Glass tube
April 26	—	25	—	23	——	92.0	Not covered
May 17	24	26	19	22	79.0	84.7	Bark, not covered; cleft, with glass tube
June 14	23	32	19	27	82.6	84.3	Bark, with glass tube; cleft, not covered
July 14	13	18	13	16	100	88.8	Glass tube
July 28	18	—	17	—	94.4	——	Not covered
July 29	14	16	13	15	92.8	93.7	Bark not covered; cleft, glass, tube
Aug. 4	12	22	10	12	83.3	86.3	Not covered
Aug. 18	—	20	—	18	——	90.0	Sphagnum moss
Sept. 15	—	25	—	23	——	92.0	Not covered
Sept. 23	18	—	16	—	88.8	——	Glass tube
Oct. 13	14	19	13	17	92.8	84.2	Banana leaf petiole
Oct. 14	—	20	—	19	——	95.0	Not covered
Nov. 3	—	15	—	13	——	86.6	Glass tube
Nov. 4	13	10	12	8	92.3	80.0	Bark, not covered; cleft, sphagnum moss
Dec. 20	15	12	14	10	93.3	83.3	Banana leaf petiole
Dec. 20	—	18	—	16	——	88.8	Not covered
Average...	—	—	—	—	84.6	81.1	

TABLE 4

Number of grafted Liberica on Quillou

DATE	NUMBER INSERTED		LIVING PLANTS 3 MONTHS AFTER INSERTION		PERCENTAGE OF SUCCESS		COVERING
	Bark	Cleft	Bark	Cleft	Bark	Cleft	
1928							
Jan. 27	19	31	10	20	52.6	64.5	Bark with glass tube; cleft not covered
Feb. 22	—	28	—	22	——	78.5	Glass tube
Feb. 23	22	—	18	—	81.8	——	Not covered
March 23	—	16	—	11	——	68.7	Glass tube
March 26	12	—	8	—	66.6	——	Glass tube
March 28	—	22	—	14	——	63.6	Not covered
April 29	12	16	11	13	91.6	81.2	Glass tube
April 29	13	14	10	12	76.9	86.4	Not covered
May 15	24	25	20	23	83.3	92.0	Bark, not covered; cleft, with saw dust
June 14	25	26	9	11	36.0	42.3	Glass tube, no shade; bark, not covered
July 14	15	23	11	12	73.3	52.0	Cleft, with glass tube; bark, not covered
July 15	27	16	24	13	88.8	81.2	Bark, with glass tube; cleft, not covered
1929							
April 25	—	17	—	14	——	82.3	Banana leaf petiole
April 26	14	—	12	—	85.0	——	Not covered
Average...	—	—	—	—	73.6	72.0	

TABLE 5

Number of grafted Liberica on Excelsa.

DATE	NUMBER INSERTED		LIVING PLANTS 3 MONTHS AFTER INSERTION		PERCENTAGE OF SUCCESS		COVERING
	Bark	Cleft	Bark	Cleft	Bark	Cleft	
1928							
Aug. 25	—	20	—	19	——	95.0	Banana leaf petiole
Aug. 13	9	22	8	20	88.8	90.0	Cleft, with banana leaf petiole; bark, not covered
Aug. 26	5	—	4	—	80.0	——	Not covered
Sept. 2	13	17	12	15	92.3	88.2	Cleft, not covered; bark, saw dust
Sept. 15	—	15	—	13	——	86.6	Glass tube
Oct. 6	—	20	—	17	——	85.0	Banana leaf petiole
Oct. 7	16	—	14	—	87.5	——	Not covered
Nov. 10	18	26	16	20	88.8	74.6	Bark, glass tube; cleft not covered
Nov. 17	—	18	—	16	——	88.8	Not covered
Dec. 8	18	15	17	13	86.6	86.6	Banana leaf petiole
Dec. 9	—	16	—	14	——	87.5	Not covered
Average...	—	—	—	—	87.3	87.0	

TABLE 6

Number of grafted Arabica on Quillou

DATE	NUMBER INSERTED		LIVING PLANTS 3 MONTHS AFTER INSERTION		PERCENTAGE OF SUCCESS		COVERING
	Bark	Cleft	Bark	Cleft	Bark	Cleft	
1928							
Jan. 28	13	—	5	—	38.4	—	Glass tube
Jan. 30	—	25	—	10	—	40.0	Not covered
March 16	—	16	—	5	—	31.2	Glass tube
April 26	—	10	—	2	—	20.0	Glass tube
May 18	—	25	—	20	—	80.0	Glass tube
May 23	23	—	15	—	65.2	—	Not covered
July 11	—	32	—	16	—	50.0	Not covered
July 12	18	—	14	—	77.7	—	Sawdust
Sept. 2	10	15	7	11	70.0	73.3	Bark, not covered; cleft, sawdust
Sept. 8	—	10	—	8	—	80.0	Glass tube
Oct. 11	8	12	6	9	75.0	75.0	Glass tube
Oct. 18	—	10	—	7	—	70.0	Not covered
Average. . .	—	—	—	—	65.2	57.7	

TABLE 7

Number of grafted Arabica on Excelsa

DATE	NUMBER INSERTED		LIVING PLANTS 3 MONTHS AFTER INSERTION		PERCENTAGE OF SUCCESS		COVERING
	Bark	Cleft	Bark	Cleft	Bark	Cleft	
1929							
Feb. 2	—	14	—	10	—	71.4	Banana leaf petiole
April 26	15	—	1	—	6.6	—	Not covered
April 29	—	9	—	8	—	89.0	Banana leaf petiole
May 14	2	21	0	6	0.0	28.0	Bark, not covered; cleft, with glass tube
Average. . .	—	—	—	—	3.3	62.8	

TABLE 8

Summary of results

BARK		CLEFT	
Month	Average success each month	Month	Average success each month
	per cent		*per cent*
January	51.8	January	63.1
February	77.9	February	74.9
March	71.5	March	59.2
April	71.7	April	77.6
May	59.9	May	73.0
June	66.2	June	70.0
July	86.1	July	75.9
August	81.9	August	89.5
September	84.6	September	85.2
October	86.7	October	81.8
November	91.2	November	83.5
December	89.7	December	85.7
Average	74.8	Average	76.6

ABSTRACT[1]

An investigation on the emigration of Ilocanos under contract to the Hawaiian Sugar Planters' Association from the provinces of Ilocos Sur and Ilocos Norte: the economic and social causes. QUINTIN A. EALA. (*Thesis presented for graduation, 1927, from the College of Agriculture, No. 308; Experiment Station contribution No. 649*)—The investigation was conducted to ascertain the ecnomic and social causes of the emigration of a large number of the inhabitants of the two Ilocos provinces to Hawaii. The survey included 473 persons engaged in various occupations as follows: 174 or 36.79 per cent were farmers; 76 or 16.07 per cent, public school pupils; 50 or 10.57 per cent, tenants; 13 or 2.75 per cent, carpenters; 11 or 2.33 per cent, *cargadores;* and 21 or 4.44 per cent, sailors blacksmiths. general laborers, municipal police, *camineros*, a fisherman, a government clerk and a local agent of the Hawaiian Sugar Planters' Association. Seventy-nine or 16.7 per cent were women and 11 or 2.33 per cent children.

There were 342 male emigrants capable of field work. Their investments at the time they emigrated to Hawaii were valued at approximately ₱50,616, an average of ₱148 an emigrant. At the same time 273 of this group of laborers had an annual income of approximately ₱50,920, an average of ₱189.29 an emigrant.

Two hundred five male emigrants, 79 of whom took their wives and families with them, were married. Out of the 473 emigrants, included in the survey, 65.17 per cent were able to read and write either English, Spanish or Ilocano, or Ilocano and either of the two languages or all three languages.

The important economic causes of the emigration movement were the unfavorable living conditions in both provinces; the higher wages offered the laborers in Hawaii than are offered in the Philippines; and the inducement created by the considerable remittances made by Filipino laborers in Hawaii to their families in the Ilocos provinces. There were also 57 emigrants or 12.07 per cent of the whole, who chose to go to Hawaii because of bigamy, personal quarrels or the inherent love of the Ilocano youth for adventure.

—*Abstract by Quintin A. Eala.*

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[1] Abstract prepared as part of required work in English 6, College of Agriculture.

COLLEGE AND ALUMNI NOTES

Dean Gonzalez and family spent three weeks in Baguio, the Darjeeling of the Philippines, in April.

At the commencement exercises in Pagsanjan Academy, in March Dean Gonzalez gave the principal address.

On March 22, the birthday of the late Dean Baker, the faculty, students, and Campus laborers of the College each wore a white carnation as an expression of love and gratitude to the man who will always be known as one of the builders of this College and the helpful friend of teachers, students, and laborers.

This beautiful custom was first observed, March 22, 1929.

Prof. Emma S. Yule, head of Department of English, returned to the Campus the first week in April from a year's leave. Professor Yule returned to the United States *via* Suez Canal. She spent some time in Java and a month in Bangkok where she collected material for an article on the Siamese women which will appear in this year's *Scribner's Magazine* under the title, "Siamese Women: Where and Whither." Miss Yule made a rather hurried trip through Palestine and Syria; sailed for Athens from Beirut; from Constantinople she went to Budapest by train. In Europe, good fortune brought her to Geneva at the time of opening of the session of the League of Nations; by further good luck she was present at two interesting sessions. She reached New York September 29; the winter months were spent in Pasodena, California. It is Miss Yule's verdict that of all the beautiful views she saw during her year of roaming, not one is more satisfying to eye and soul than that seen from veranda of Copeland House.

While in the United States Miss Yule met Dr. and Mrs. Trelease, Dr. and Mrs. McWhorter, and Prof. E. Gertrude Madison, all former members of the College faculty. Doctor Trelease is now professor of botany in Columbia University, receiving a generous increase in salary last year. Doctor McWhorter is head of plant pathology department in the Agricultural College at Corvallis, Oregon, and also will carry on research on ornamentals under the United States Department of Agriculture. Professor Madison is in English department in Waynesburg College, Waynesburg, Pennsylvania. All were much interested in the progress of our College and sent cordial greetings to old friends.

An illustrated popular article by Dr. F. M. Fronda describing the work of developing the Los Baños Cantonese chickens in this College was published in the April, 1930, issue of the *Philippine Magazine.*

At the request of the research bureau of the Philippine Sugar Association, Dr. L. B. Uichanco made a trip to Negros during the latter part of March in order to co-operate in the study of methods of field control of sugar cane white grubs.

Two publications by the University of California from the pen of Dr. Irving A. Leonard are given considerable space in the review section of a recent number of *Hispania.* These books have a special interest for this College as Doctor Leonard was head of the Engineering Department in 1922. He was compelled to resign because of illness of his wife.

The publications are:

Don Carlos Sigüenza y Góngora; A Mexican Savant of the Seventeenth Century—287 pages; and *Ensayo Bibliográfico de Sigüenza y Góngora*—65 pages.

To quote from review on the first: "Doctor Leonard is an admirable story-teller (rather uncommon among scholars), and in this fascinating volume he has digested a great wealth of material into a biography so coherent and flowing as to deserve mention for these qualities.'

The Los Baños Limnological Station of the Department of Entomology has recently acquired a motor boat for use in the ecological survey of the waters and shores of Laguna de Bay.

Three hundred and eighty five students were registered in the College Summer School. Of these six were new registrants. There were seven co-eds.

Dr. Fronda's extension course in poultry raising is attracting attention among the teachers in the Bureau of Education. In the Summer School seventeen students were enrolled, the majority of whom are industrial teachers. This course was started in 1924 with an enrollment of only six students.

At close of College year Miss Esther Anderson of the English Department staff resigned and returned to the United States *via* Suez Canal. Miss Caroline V. Lee of same staff went on vacation returning to the United States *via* Panama Canal. During the summer recess Miss Anne Cole went to Angkor Wat and Siam, and Miss Sue Denny went to China. Both teachers are in English Department.

The interior of the Administration Building has again been readjusted to meet new conditions. The library has been enlarged to accommodate the increasing book stacks. The library of the U. P. Rural High School is now combined with the main library. The Registrar's Office has been expanded to facilitate registration and to provide additional space for the files of student's records. To provide for these changes, the Rural Economics Department was moved to Old College Building.

Mr. S. M. Cendaña, instructor in entomology, went on a two months accrued leave beginning April 5. During this period he was engaged by the Philippine Sugar Association to assist in pest control work in Negros.

Mr. Arsenio Y. Coronel, assistant in entomology, joined the students' educational tour to Singapore conducted during April by the Dollar Steamship lines. During the trip the principality of Johore was also visited.

The Graduating Class of 1930 of the College of Agriculture carries the following names on its roster:

Bachelor of Science in Agriculture

1. Buenaventura B. Aguanta
2. Felix R. Amparado
3. Claudio G. Arellano
4. Perfecto Boncato
5. Quintin A. Eala, B. Agr. '27
6. José C. Gaton
7. Perpetuo Gavarra, B. Agr. '23
8. Antonio V. Guanzon
9. Estanislao Ilarina
10. Pascual M. Matulac
11. (Miss) Victoria B. Mendiola
12. Toribio Mercado, B. Agr. '26
13. Miguel R. Ocampo, B. Agr. '24
14. Dominador D. Pascual
15. Salvador T. Pacion
16. Conrado T. Reyes
17. Fernando Reyes, B. Agr. '25
18. Fidel del Rosario
19. Rafael B. Rotor, B. Agr. '28
20. Isidro Samia
21. Ambrosio V. San Pedro
22. Marias P. Sucaldito
23. Francisco J. Valdes
24. Fabio M. Venezuela
25. Serafin Villodres
26. Tito A. Yotoko

Bachelor of Science of Sugar Technology

1. Agustin L. Hermano
2. Ernesto B. Jamora
3. Agustin L. de Luzuriaga
4. Quirino D. Rendon
5. Manuel Villano *cum laude*

Bachelor of Agriculture

1. Fidel H. Alonte
2. Valentin G. Amon
3. Domingo R. Cabrera
4. Magdaleno M. Caguicla
5. Artemio E. Gesmundo
6. Joe R. Haynes
7. Basilio Iledan
8. Porfirio E. Jain
9. Pedro B. Juachon
10. Emilio M. Kraft
11. Epitacio A. Lanuza
12. Felix D. Lazo
13. Jacinto B. Leoncio
14. Jesus P. Mamisao *cum laude*
15. Urbano C. Manabat
16. Ricardo T. Marfori *cum laude*
17. Monico Necesito
18. Victorio R. Olan
19. José G. Padilla
20. Geronimo F. Pascua
21. Hilario T. Ramos
22. Társilo Romero
23. Severino Salvado

Ricardo T. Marfori, B. Agr., was awarded the Gonzales Scholarship Medal for the highest scholastic records in the Class of 1930.

The scholarship aid from the Baker Memorial Fund was awarded to Ambrosio V. San Pedro. This is the first award of this aid.

Miss Victoria B. Mendiola, B. S. A. '30, has the unique honor of being the first woman to be graduated from the College of Agriculture. She was admitted as a freshman in June, 1925, thus completing the regular four year course in five years. During the greater part of her College work she has been a student assistant. Miss Mendiola majored in Plant Pathology; she worked in this laboratory as student assistant. Since her graduation she has been appointed graduate assistant in this department. Miss Mendiola is a sister of Doctor Mendiola, Head of the Department of Agronomy.

In the first of the annual dual tennis meets between the U. P. Manila and the U. P. Los Baños faculty tennis teams for the possession of the

Palma Cup, the Los Baños team won—six matches to three. The games were played on the Philippine Columbian Association courts in Manila on April 6, 1930. Hereafter the meets will be held on February 22 of each year; the place for the games to be decided by the previous year's winner. The Cup must be won three times before it becomes the permanent possession of either team.

The results of the meet follow:

In Singles: Dr. Adriano (Los Baños) defeated Dr. Mandanas (Manila), 6-2, 6-4.
Dr. Gordon (Los Baños) defeated Prof. Zafra (Manila), 5–7, 6–0, 6–1.
Dr. Mondoñedo (Los Baños) lost to Dr. Velardo (Manila), 3–6, 1–6.
Mr. Baltazar (Los Baños) won by default.
Mr. Tolentino (Los Baños) won by default.

In Doubles: Dean San Agustin–Prof. Sulit (Los Baños) won from Prof. Austria–Prof. Manguerra (Manila), 6–4, 8–6.
Dr. Espino–Mr. Peralta (Los Baños) lost to Dr. Tan–Prof. Virata (Manila). 2–6, 3–6.
Mr. Ebro–Mr. Soliven (Los Baños) lost to Prof. Bartolomé–Prof. Gana (Manila), 5–7, 12–10, 0-6.
Mr. Catambay–Mr. Costa (Los Baños) won by default.

Gomez and Santos and Collado were with the winning Los Baños team as substitutes,

THE PROGRAM OF THE U. P. LOS BAÑOS COLLEGES ANNUAL PHYSICAL EDUCATION DAY WHICH WAS HELD MARCH 7, 1930

Afternoon Program

Dual Athletic Meet: Faculty–Alumni *vs.* C. A. Undergraduate Seniors

1. Indoor Baseball (won by Faculty-Alumni—9–5)
2. Cageball Volleyball (won by Seniors—11–6)
3. Tug of War (Won by Faculty-Alumni)
   (Prize: A pennant donated by Athletic Supply Company). Won by Faculty-Alumni)

Evening Program

Athletic Commencement: Annual Distribution of Athletic Prizes

1. "Varsity March" - - - - - - - Community Singing
   Led by Mr. Honorio Ylizardo, (Mrs. Bousman at the piano)
2. Opening Remarks - - - - - Mr. Ramón P. Tolentino, Jr.
   Instructor in Physical Education
3. On the Screen: (*a*) "Sporting Rhythm"—A One-Reel Picture
   (*b*) "Rah! Ra ! Song"—Community Singing
   (*c*) "Twinkle, Twinkle"—Another Sportlight
4. Distribution of Prizes: U. P. Los Baños Tenth Annual Intramural Track and Field Championship by - - - - - - Prof. Carlos Sulit
   Forestry Faculty Member, U. P. Board of Athletic Control
5. On the Screen: (*a*) "Beauty Spots"—A One-Part Picture
   (*b*) A Popular Song—Community Singing
6. Distribution of Prizes:
   (*a*) U. P. Los Baños Fifth Annual Intramural Athletic League
   (*b*) 20th Anniversary of the College of Agriculture Athletic Games
   Dr. Alexander Gordon
   College of Agriculture Faculty Member, U. P. Board of Athletic Control

7. A Short Talk—"My Most Thrilling Race" - - Mr. Pedro Yatar
Captain, U. P. Los Baños Track and Field Team

8. Distribution of Prizes:
(*a*) Miscellaneous Prizes
(*b*) College Athletic Letters and Certificates - - Dean Gregorio San Agustin
Chairman, Los Baños College Committee of Athletic Management

9. On the Screen: (*a*) "The Collegians"—A Two-Part Sports Story
(*b*) "Wahoo Song"—Community Singing

10. Remarks and Distribution of Prizes: N.C.A.A. and P.A.A.F. Meets, and U. P. Athletic Letters and Certificates - - - Prof. Cándido C. Bartolomé
Physical Director, U. P.

11. "Philippines, My Philippines" and "America" - - The Audience

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Athletic Letter Men, 1929-1930 Season

Baseball

1. Moises Angel (A)
2. Adolfo Castillo (A)
3. Basiliso Damian (A)
4. Hermenegildo Farolan (A) (P)
5. Anselmo Guillen (A)
6. Cornelio Lemoncito (A)
7. Perfecto Ocampo (A) (P)
8. Eduardo Perez (A)
9. Aniano Paner (A) (P)
10. Vicente Cariño (F)
11. Gregorio Santos (F)

Soccer Football

1. José S. Austria (A) (P)
2. Elias Grapa (A) (P)
3. Newton Jison (A) (P)
4. Thuan Komkris (A) (P)
5. Cornelio Lemoncito (A)
6. Thonghaya Punyasingha (A) (P)
7. Viradeja Sawat (A)
8. Tulaya Silpi (A) (P)
9. Phanom Smitananda (A)
10. Charas Suebsaeng (V) (P) (S)
11. José Zabarte, Jr. (A)

Volley-Ball

1. Moises Angel (A)
2. Raul R. de Arana (A)
3. Santiago Banilan (A)
4. Felipe Crisostomo (A)
5. Agaton de la Cruz (A)
6. Alberto Elefaño (A)
7. Felicisimo Maceda (A)
8. Guillermo Manalo (A)
9. Hermogenes Gilbero (A)
10. Felix Arriola (A)

Rifle Team

1. Felix Enrile (P)
2. Francisco Gestoso (P)
3. Salvador B. Oliveros (P)
4. Guillermo Palis (P)

Basketball

1. José S. Austria (A)
2. Alberto Elefaño (A) (P)
3. Manuel Hollero (A)
4. Cornelio Lemoncito (A)
5. Julito Marcos (A) (P)
6. Briccio Reynoso (A) (P)

Boxing

1. Magdaleno Caayupan (F)
2. Adolfo Castillo (A)
3. Vicente Hermoso (V)
4. José C. Mendoza (A)
5. Gil Pabillo (V) (P)
6. Francisco Sevilleno (A) (P)
7. Estanislao Ybalio (A)

Track and Field (including relays)

1. Pascual N. Andres (A) (P)
2. José S. Austria (A) (P)
3. Leonardo Banaag (A) (P)
4. Pedro Cagalawan (F)
5. Basiliso Damian (A)
6. Eleuterio Enriquez (A) (P)
7. Epitacio Lanuza (A)
8. Ceferino Magno (A) (P)
9. Guillermo Manalo (A) (P)
10. Amado Paggao (A) (P)
11. Eduardo Perez (A) (P)
12. Theodore Schuck (A) (P)
13. Pedro Yatar (A) (P)
14. José Zabarte, Jr. (A) (P)

Swimming

1. Moises Unson (A)

Tennis

1. José S. Austria (A)
2. Santiago Ledesma (F)
3. Pee Tek Hap (A)
4. Charas Suebsaeng (V)
5. José Utzurrum (A)

(A) = Agriculture (College Letter)
(V) = Veterinary (College Letter)
(F) = Forestry (School Letter)
(S) = Sweater (U. P.: awarded after four years' regular membership in a U. P. team)
(P) = Philippines (University Letter)

NEWSPAPER SCIENCE[1]

Of the various concomitant evils of civilization, one of the most serious is the progressive degeneration of certain organs of sense which in more primitive humans and in lower animals are so vitally important to self-preservation. Having hedged himself with an elaborately artificial system of organization against the hostile forces of Nature, and his inventive genius having provided him with almost uncanny tools that have largely relieved him from working, the life activities of civilized man have been practically reduced to mere routine wherein the necessity for thinking has been all but dispensed with. His primary wants—food, clothing, and shelter—are brought to him as conveniently finished products; and in time he comes to take for granted those things which his ancient forbears could obtain only through continuous painstaking effort.

The habit of dependence on ready-made goods has extended even to the absorption of human knowledge. Where formerly acquisition of learning was the privilege of a few who were willing to forsake the more material things of life and subject themselves to the drudgery of poring over musty tomes among the shelves of monastic libraries, now the average man or woman, with the expenditure of a few centavos, may keep abreast with the general progress of the world in the arts, science, and literature through the medium of the newspapers and periodicals. The part, indeed, that modern journalism has played in the cultural advancement of any nation cannot be overestimated. The dailies, the Sunday supplements, the weeklies, and the popular monthly magazines have come to stay; they form an indispensable adjunct to the central scheme of our social structure.

But the newspapers, although usually an agency for good, may become a tremendous power for evil under misguided, if not unscrupulous, editorial direction. How often has public opinion been depraved beyond repair through careless, half-baked reporting which led to distortion or misrepresentation of facts and irresponsible editorial effusions which appealed to emotion rather than to reason, to personalities rather than to larger questions of principles! Thus, the worthy president of our University, Dr. Rafael Palma, once was constrained to characterize Manila newspapers as "almost yellow."

Science with its zeal for exactness has often suffered in the hands of popular journalists. Scientists busy as they are in their laboratories, fields

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[1] General Contribution from the College of Agriculture No. 268.

THE PHILIPPINE AGRICULTURIST, VOL. XIX, NO. 2, JULY, 1930.

of exploration, and investigation are forced to resort to the use of precise and tersely expressed scientific terms in reporting the results of their researches. To cap all this, many technical investigators have not the gift to translate the records of their findings into a language and style that would appeal to the popular mind, notwithstanding the brilliant achievements in this direction by such scientific luminaries as Darwin, Huxley, Pasteur, and others, whose writings are intelligible to the multitude. Hence very often, popularization of science has been left to the mercy of people who, because of lack of previous training and different line of occupation, are frequently not qualified to make proper evaluations. The result is at times disconcerting. Relatively unimportant matters are magnified into sensational headlines, usually with altered interpretations, while the more fundamental parts are either left out or relegated to the background, because they do not happen to furnish "good copy" or do not fit in with the paper's editorial policy.

To one who has dedicated his life to science the effect of this incursion of irresponsible journalism into its realm is altogether shocking. He views the act with the horror of worshippers in a sacred temple when profane desecrators intrude. Even that common subterfuge of newspapermen, "the good of the public," does not justify such irreverent treatment; for the practice is dangerous, fraught with serious consequences, and is therefore against public welfare.

L. B. Uichanco
Of the Department of Entomology.

TEN MARKS OF AN EDUCATED MAN

He keeps his mind open on every question until the evidence is all in.

He listens to the man who knows.

He never laughs at new ideas.

He cross-examines his day-dreams.

He knows his strong point and plays it.

He knows the value of good habits and how to form them.

He knows when not to think and when to call in the expert to think for him.

You can't sell him magic.

He lives the forward-looking, outward-looking life.

He cultivates a love of the beautiful.—*The American Magazine.*

——*What the Colleges Are Doing.*

THE FUSARIUM DISEASE OF CORN[1]

VICTORIA B. MENDIOLA

WITH TWO PLATES AND ONE TEXT FIGURE

THE DISEASE

The *Fusarium* disease of corn (*Zea mays* L.) in the Philippine Islands was first reported as blast of kernels in 1918 by Reinking (1918), who described the disease briefly. Hitherto, however, no work has been done on this disease and its causal organism in the Philippines.

Hosts

Nearly all the varieties of corn grown in the College of Agriculture at Los Baños are susceptible to the *Fusarium* disease. The pokkah-bong disease of sugar cane (*Saccharum officinarum* L.) which occurs in Java is said to be due to *Fusarium moniliforme* Sheldon, the species which is suspected to cause the *Fusarium* disease of maize in the Philippines. The pokkah-bong disease is also reported in Cuba by Priode (1929) who states that it is caused by a species of *Fusarium*, very similar to *Fusarium moniliforme*. A species of *Fusarium* which is similar to *Fusarium moniliforme* has been found to be associated with cases of twisted-top of sugar cane in the College of Agriculture by Mr. E. F. Roldan of the Department of Plant Pathology.

In addition to diseases produced on corn and sugar cane, Hartley, Merrill, and Rhoads (1916) and Hartley and Pierce (1917) report that *Fusarium moniliforme* causes damping-off of coniferous seedlings. Henry (1923) found *F. moniliforme* virulently pathogenic on wheat, barley, and sweet corn. It also attacks rye and oats. Reinking and Wollenweber (1927) state that *Fusarium moniliforme* may be found on kernels of corn, cut ends of corn stems and leaves, interior of diseased pseudo-stems and dead floral parts of banana (*Musa sapientum* L.) and decaying undetermined plants, and soil and air.

Common names

The *Fusarium* disease of corn in the United States was described by Sheldon (1904) as corn mold, and the same trouble in the Philippines was reported by Reinking (1918) as blast of kernels. Manns and Adams (1921) first called this malady kernel rot of corn. In 1923, they stated that dry rot seems to be more applicable for the kernel rot of corn produced by *Fusarium moniliforme* and *Gibberella saubinetii* (Mont.) Sacc. than that produced by *Diplodia zeae* (Schw.) Lév.

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Edgerton and Kidder (1925) mention pink rot as a disease produced by *Fusarium moniliforme* Sheldon. The *Fusarium* disease of maize was included by Burrill and Barrett (1909) and Pammel, King, and Seal (1916) under ear rots; while Holbert, Burlison, Koehler, Woodworth, and Dungan (1924) designate the malady as *Fusarium* ear rot. Wenholz and Darragh (1927) describe this trouble as *Fusarium* (splitting) disease of the corn grain.

In the Tagalog regions of the Philippines, the *Fusarium* disease is referred to by the farmers as *namumutok* or *namumusangsang* which means the blasted condition of the kernels.

History, geographical distribution, and economic importance

Manns and Adams (1921) state that the ear rots of maize have been known for decades although the parasites responsible for them have only recently been identified.

The *Fusarium* disease of corn was first studied in 1904 in Nebraska by Sheldon (1904) who found that the causal fungus is an undetermined species of *Fusarium* and described it as *Fusarium moniliforme.* At that time Sheldon believed that *F. moniliforme* was the cause of forage poisoning but experiments conducted later on disproved his contention. Since 1904, *Fusarium moniliforme* has been known in America to be a common parasite of corn. According to Pammel, King, and Seal (1916) the *Fusarium* disease of corn made its first appearance in Iowa in 1914. Van der Bijl (1916) in South Africa mentions a species of *Fusarium* as being associated with moldy corn. Valleau (1920) considers *Fusarium moniliforme* a parasite which causes root and stalk rots of corn under field and laboratory conditions. In 1920 Norton and Chen (1920) called attention to a new corn-seed parasite in Maryland which they reported as *Oospora verticilloides* Sacc. According to Manns and Adams (1923) *Oospora verticilloides* Sacc. is no doubt identical with *Fusarium moniliforme* as shown by the size of the microconidia and their method of formation. Owing to the fact that no macroconidia are described for *Oospora verticilloides*, Wineland (1925) does not consider it identical with *Fusarium moniliforme* Sheldon. Manns and Adams (1921) found *Fusarium moniliforme* in a large number of samples of seed corn from widely different sources in Delaware.

Sherbakoff (1922) found that in Tennessee, and in other states of the United States, the most common *Fusarium* of corn is *Fusarium moniliforme.* Branstetter (1922) in 1921 found that, in Missouri, corn was heavily infected with *F. moniliforme*, *Cephalosporium sacchari*, and *Diplodia zeae* in the order named. Melchers and Johnston (1923) report that *F. moniliforme* is by far the most common organism on corn in Kansas. Moore (1923) in

New Jersey found that of the four fungi associated with corn seed, *F. moniliforme* and *Cephalosporium* sp., are the two most important organisms. Holbert, Burlison, Koehler, Woodworth, and Dungan (1924) state that the most common fungus appearing in germination tests of seed corn is *Fusarium moniliforme.* Edgerton and Kidder (1925) found *F. moniliforme* in abundance on corn in Louisiana.

According to Wenholz and Darragh (1927), the disease known as root, stalk and ear rots due to *Fusarium* and *Gibberella* species are widely distributed in New South Wales and throughout Australia and that no maize crop is entirely free from them. Stover (1920), Gilman (1921), and Kirby (1922) also mention species of *Fusarium* on corn. .

The disease seems to be widely distributed in the United States, in Australia, in New South Wales, Central America (Reinking and Wollenweber, 1927), and probably in South Africa. It is also present in the College of Agriculture vicinity of Los Baños, Laguna, Philippine Islands. Judging from the world-wide distribution of the fungus, there is very little doubt that the malady occurs also in other provinces of the Philippines where corn is grown.

In the Philippines, the losses caused by the *Fusarium* disease of corn, as well as of other diseases, have not been determined. Baker (1917) and Reinking (1918) estimate that about 10 per cent of all agricultural crops are lost owing to disease.

In Iowa during the season of 1914, the loss of corn caused by the *Fusarium* disease was estimated to be more than ₱30,000,000 ($15,000,000).

Melchers and Johnston (1923) in Kansas found *F. moniliforme* to occur to a greater or lesser extent on over 95 per cent of all ears tested.

The kernels infected with *Fusarium,* when planted, produced low percentages of germination, reduced vigor, stunted growth of the plants, light ears owing to improper filling of the cob, premature ripening of ears and inferior quality of kernels. Each of these factors contributes to produce low yield and inferior quality of the corn crop.

SYMPTOMS AND SIGNS

Seedling stage

In inoculation experiments on corn seedlings, the most characteristic symptoms of the disease are yellowing and wilting of the leaves. These symptoms may be observed about eight days after inoculation. Complete wilting and drying of the leaves take place in from four to ten days, depending upon the size of the plants and the severity of infection by the disease.

The root system and the stem a few millimeters above the ground are completely rotted after ten days, as a consequence the seedlings lodge or fall over.

Ear stage

No pronounced symptoms on the aërial parts of the corn plant may be noted except on the ears, where the first visible symptom is the premature ripening. The ears are not fully developed and they bear kernels which are not plump and bright.

In the incipient stage of infection, the kernels are characterized by the presence of fine pinkish stripes ramifying between the pericarp and epidermis. Microscopic examination of these striped or colored kernels shows the presence of hyphae of the causal fungus.

In the advanced stage of the disease, especially with the rainy season crop, masses of mycelium hold the inner husks and silk firmly to the kernels.

When the ears are fully mature, the infected kernels swell, crack or burst open (pl. I, fig. 1 and 2) or split (Wenholz and Darragh, 1917) and expose the internal parts. These broken kernels are irregularly distributed on the ear. They are of light brown or violet color and brittle. In advanced cases of the disease the infected kernels become powdery and are easily crushed between the fingers. Microconidia and macroconidia are found in these infected kernels. The cracking of the kernels is attributed by Manns and Adams (1923) to the effect of excessive moisture and growth. These authors believe that the fungus becomes established subsequent to the cracking of the kernels. Its mycelium penetrates the tissues of the kernels both intercellularly and intracellularly.

Burrill and Barrett (1909) are of the opinion that infection causes these kernels to crack open and makes their contents starchy and crumbly.

Valleau (1920) states that the production of reddish or blue-black discoloration in the seed coat of corn during and after germination, is an indication of infection with *Fusarium moniliforme.* The same observation was noted by the writer.

CAUSAL ORGANISM

Isolation and growth in pure culture

The fungus was isolated to pure culture by picking Fusarium-infected corn kernels with a flamed pair of forceps. The kernels were flamed over an alcohol lamp in order to kill other foreign organisms on the surface. The kernels were then immersed in 1:1000 mercuric chloride solution for about one minute, washed with four changes of sterile water and then plated out in sterile petri dishes containing potato-dextrose agar. Three kernels were placed in each dish. Transfers were made from the edge of the growth that developed on the potato-dextrose agar in the plates. The subcultures used for inoculation and in the study of the morphology and physiology of the organism were obtained from the sporodochia formed on potato-dextrose agar slants.

Morphology

Mycelium. In pure culture the fungus produces aërial and submerged mycelium. The aërial mycelium ranges from scanty to medium dense and from dirty white to deep rose pink and pale hortense violet[2]. The submerged mycelium is slimy and light buff. According to Wollenweber, Sherbakoff, Reinking, Johann and Bailey (1925) this immersed gelatinous growth in general indicates degeneration and self-digestion accompanied by abnormal spore production or even sterility of the fungus. Microscopically, the mycelium is septate, hyaline, granular at first but soon becomes vacuolate, thin-walled, and either regular or irregular in outline. The cells bulge slightly in the middle.

Conidiophores. The conidiophore-and conidium-formation were studied from hanging drop preparations of dissolved potato-dextrose agar in hollow ground slides which were inoculated with a few microconidia.

The microconidia germinated readily in about five hours. About two hours after germination most of the spores produced hyaline germ-tubes at one or both ends. In 24 hours all had long hyaline germ tubes, and in 27 hours many interwoven branches were formed with microconidia scattered or in groups at the ends of the conidiophores. The tips of hyphae or lateral outgrowths of these become the conidiophores (fig. 1, c and d). In hanging drop cultures no chains of microconidia were produced. Catenulate microconidia (fig. 1b) were produced by the aërial mycelium of the plate and slant cultures. These long chains of microconidia readily developed within 24 hours.

From the hanging drop preparations one or more types of conidiophores were noted. Some were small with short lateral protrusions of the hyphae and these bear the micrononidia. In rare cases, macroconidia were also borne by them.

From the hyphal cells club-shaped conidiophores (fig. 1c) arose also, singly or in groups constricted at the points of origin, slightly bulging in the middle and tapering gradually toward the rounded distal ends. Some were single-celled while others were divided into segments and produced both macro- and microconidia. The conidiophores were at first hyaline and granular but soon became vacuolate. After they produced spores they appeared empty.

Microconidia. The microconidia (fig. 1b) were produced abundantly on all the media used. They formed long chains of as many as 30 or more spores. They are single-celled, thin-walled, hyaline with slight bluish green tints, oblong-ovoid and delicate. They are first granular, but very soon become vacuolate. They vary greatly in size. The chains are easily broken and the microconidia usually slip aside forming clusters (fig. 1d) at the terminal ends of either simple or much branched conidiophores.

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[2] The color nomenclatures followed in these studies are those of Ridgway, Robert. 1912. Color standards and color nomenclature. 43 p., 53 colored pl.; 1115 named colors. Washington, D. C.

Macroconidia. The macroconidia (fig. 1a) are sparingly developed, scattered in some old cultures and mostly produced in pseudo-pionnotes and sub-effuse sporodochia on few media, 1-5-celled, 3-septate predominating, delicate and slender, thin-walled, hyaline with very slight bluish green tint, sickle-shaped (falcate), appedicellate and pedicellate, granular, but soon become vacuolate and vary in size; chlamydospores absent.

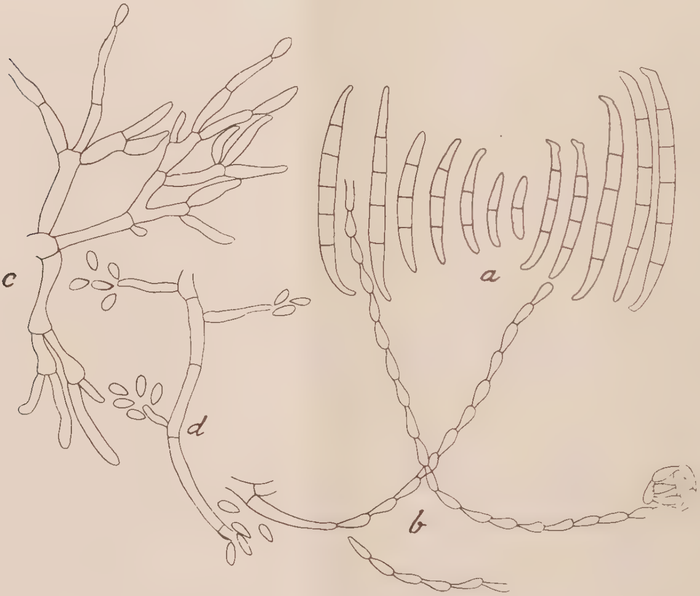

FIG. 1.—Camera lucida drawings of the Philippine *Fusarium moniliforme* Sheldon showing (*a*) Macroconidia from potato dextrose agar and oatmeal agar. (*b*) Chains of microconidia from the aërial mycelium in plate culture on corn meal agar, 17 days old. (*c*) Portions of mycelium and conidiophore from five-days-old aërial growth of the fungus on potato-dextrose agar. (*d*) Portions of mycelium and conidiophore with few scattered microconidia as seen from a hanging drop preparation of potato-dextrose agar. All figures are × 575.

Sheldon (1904) reports that the lengths of the macroconidia are 25-40μ and those of the microconidia are 5-10μ.

Hartley, Merrill, and Rhoads (1918) obtained microconidia on prune agar which were 4.8—6.3×2.2—3.1μ; and on corn meal 7.4—11.1μ in length, while Manns and Adams (1923) report that they are 7-9×2.6-3.5μ on host material and 6.7-12×2.5-3.5μ on dextrose medium and the macroconidia 19-31.5×2.5-3.5μ.

Reinking and Wollenweber (1927) found the following:

1-septate—12–18×2.25–3.5 μ.
2-septate—no measurement given.
3-septate—30–36×3–3.5 μ (23–48×2.25–4) μ.
4-septate—37–53×3–3.5 μ.
5-septate—43–66×3–3.5 μ.
On hard potato agar (2 months old)
0-septate 42 per cent; 9×3 μ (5–14×1.75–3.5) μ.
1-septate six per cent; 19×3.5 (14–23×2.75–3.5) μ.
2-septate two per cent; 22×3.25 μ (21–23×3–3.5) μ.
3-septate forty-four per cent; 33×3.25 μ (23–45×2.75–4) μ.
4-septate four per cent; 43×3.5 μ (37–53×3.5) μ.
5-septate two per cent; 45.5×4 μ (41–50×3–3.5) μ.

Manns and Adams (1923) report that Saccardo found the microconidia on host material to be 8-10×2.5-3μ.

The measurements of spores from different media obtained by the writer are as follows:

On potato cylinders 17 days old
0-septate—66 per cent.
1-septate—20 per cent.
2-septate— 2 per cent.
3-septate—12 per cent.
On potato agar + two per cent dextrose 22 days old
0-septate—90 per cent; 5.5–13.2×2.2–4.5 μ, av. 6.1×2.9 μ.
1-septate— 6 per cent; 9.1–16.7×2.8–4.2 μ, av. 12.7×3.5 μ.
2-septate— 2 per cent.
3-septate— 2 per cent.
On potato agar + four per cent dextrose 17 days old
0-septate—89 per cent.
1-septate— 8 per cent.
2-septate— 1 per cent.
3-septate— 2 per cent.
On nutrient agar 19 days old
0-septate—100 per cent; 6.9–20.1×2.5–4.9 μ, av. 11.2×3.7 μ.
On nutrient agar + acid 19 days old
0-septate—100 per cent; 3.5–10.9×1.8–5.7 μ, av. 9.9×3.5 μ.
On nutrient agar + four per cent dextrose 19 days old
0-septate—100 per cent; 6.1–13.9×1.9–5.4 μ, av. 8.4×3.4 μ.
On corn meal agar 20 days old
0-septate—100 per cent; 3.4–13.4×4.7 μ, av. 6.9×2.7 μ.
On steamed rice + acid 11 days old
0-septate—100 per cent; 2.3–10.6×1.3–4.1 μ, av. 6.1×2.3 μ.
On steamed rice 29 days old
0-septate—40 per cent.
1-septate—20 per cent.
2-septate—10 per cent.
3-septate—30 per cent.
On corn ear milk stage 19 days old
0-septate—64 per cent; 4.9–11.8×2.2–4.4 μ, av. 9.6×3.2 μ.
1-septate—16 per cent; 12.2–19.1×2.8–4.4 μ, av. 14.9×3.5 μ.

2-septate— 8 per cent; 18.7–23.6×2.8–4.4 μ, av. 21.2×3.7 μ.
3-septate—12 per cent; 22.2–31.9×2.5–4.5 μ, av. 27.4×3.8 μ.
On oatmeal agar 72 days old
0-septate—11 per cent; 6.0–11.1×2.2–5.2 μ, av. 8.3×3.5 μ.
1-septate— 4 per cent; 13.5–23.2×2.8–3.5 μ, av. 16.9×3.1 μ.
2-septate— 2 per cent; no measurement.
3-septate—81 per cent; 29.8–40.9×3.6–4.8 μ, av. 37.2×4.4 μ.
4-septate— 2 per cent; 38.7–48.6×2.5–4.8 μ, av. 43.2×3.7 μ.
5-septate— 1 per cent; 41.6–49.4×2.5–4.6 μ, av. 46.5×3.7 μ.
On water agar 20 days old
0-septate—100 per cent; 4.7–9.4×2.2–3.7 μ, av. 6.7×2.9 μ.
On oatmeal agar 32 days old
0-septate—78 per cent.
1-septate—12 per cent.
2-septate— 2 per cent; 15.9–27.8×3.3–4.4 μ, av. 21.5×3.6 μ.
3-septate— 8 per cent; 20.8–34.7×3.4–4.1 μ, av. 30.8×3.6 μ.
On oatmeal agar + 2 per cent dextrose 31 days old
0-septate— 9.5×4.5 μ (6.2–13.8×2.5–5.7) μ.
1-septate—16.6×3.3 μ (9.5–26.7×2.1–5.2) μ.
2-septate—26.3×3.4 μ (17.7–34.0×2.5–4.7) μ.
3-septate—41.8×3.8 μ (17.3–50.3×3.5–5.2) μ.
On potato dextrose agar 48 hours old
0-septate—6.5×2.7 μ (2.8–13.9×1.9–4.3) μ.
Average length and width of different types of spores
0-septate—72.6 per cent; 8.1×3.00 (6.1–11.2×2.3–3.7) μ.
1-septate— 9.6 per cent; 14.8×3.3 (12.7–16.9×3.1–3.5) μ.
2-septate— 2.5 per cent; 21.3×3.6 (21.2–21.5×3.6–3.7) μ.
3-septate—12.3 per cent; 31.8×4 (27.4–37.2×3.6–4.4) μ.
4-septate— 2 per cent; 43.2×3.7 (38.7–48.6×2.5–4.8) μ.
5-septate— 1 per cent; 46.5×3.7 (41.6–49.4×2.5–4.6) μ.

Physiology

The growth and color of the Philippine corn *Fusarium* were studied in plate cultures using potato agar; potato agar + two per cent dextrose; potato agar + four per cent dextrose; nutrient agar; lactose-beef-extract agar; corn meal; steamed rice; corn meal agar and oatmeal agar.

The results of this study are given in table 1.

The growth and color of the fungus were further studied on slant cultures, to some of which dextrose and a few drops of 25 per cent lactic acid had been added. The media used were nutrient agar; nutrient agar+three drops of twenty-five per cent lactic acid; nutrient agar+eight per cent dextrose; potato agar; potato agar+three drops of twenty-five per cent lactic acid; potato agar+eight per cent dextrose; corn meal; corn meal agar +three drops of twenty-five per cent lactic acid; corn meal agar+eight per cent dextrose; oatmeal agar; oatmeal agar+three drops of twenty-five per cent lactic acid and oatmeal agar+eight per cent dextrose. The results of this study are given in table 2.

A further study was made of the changes in color of the substratum and types of growth and spores produced.

1. Cultures five days old on potato agar were characterized by a thin growth of the fungus. The aërial mycelium was thin, scanty, and white. In older cultures the growth became dense, pale salmon color with slight traces of pale hortense violet. On potato agar treated with acid the growth when examined after 64 days had 0–, 1–, 2–, and 3-septate conidia of which the 0–septate predominated, while the 3–septate were rare.

2. Cultures on potato agar+two per cent dextrose, five days old, were characterized by an aërial mycelium that was dense, the hyphae at the edge of the slant were twisted, and the growth was pale hortense to phlox pink. When 12 days old the color became pale flesh with bluish green spots at the base of the slants and the substratum was hortense violet and light amparo purple. Cultures 47 days old developed light venetian pink pionnotes and light sofrano pink sporodochia. Some of the sporodochia became blue-black in color. Upon microscopic examination, the writer noted 0–, 1–, 2–, and 3–septate conidia. The 2–, and 3–septate spores were rare.

3. The colony on potato agar+four per cent dextrose was noted after 7 days to be characterized by an aërial mycelium that was medium dense, the hyphae at the edge of the slant appeared twisted, and the growth was very pale hortense violet to cameo pink. The substratum was light amparo purple. When 15 days old, the color became pallid-bluish violet at the center and rose pink along the sides of the colony. The substratum changed to pansy violet. When 66 days old, the aërial mycelium became pallid-bluish violet and the substratum, bordeaux. The 0–, 1–, 2–, and 3–septate conidia were present, but the 0–septate predominated.

4. Cultures on nutrient agar at 7 days of age produced submerged, slimy, light buff mycelium. The fungus did not change the color of the medium, although it produced slight traces of violet after several days. When 15 days old up to a month or more, scanty, short, dirty white aërial mycelium was produced, but the color of the substratum remained the same. When 65 days old, 0–, 1–, 2–, and 3–septate conidia were produced, the 0– and 1–septate being more abundant than the 2– and 3–septate spores. On the nutrient agar to which three drops of lactic acid had been added only the 0–septate were produced.

5. Cultures on lactose-beef-extract agar which were 8 days old were characterized by the production of aërial mycelium which was medium dense, fluffy, and dirty white. The fungus did not change the color of the substratum. When 20 days old, the mycelium became short, woolly, and white, and the substratum was changed to ochraceous buff.

6. The observation on corn meal was made after 7 days and the cultures were characterized by an aërial mycelium which was medium dense, the hyphae at the edge of the slant were short and twisted, and the growth was pale hortense violet, pale flesh pink, and jasper pink. The substratum

was flesh ochre and pale hortense violet. When 68 days old, 0–, 1–, and 3–septate conidia were present, although the 2 - and 3–septate were rare.

7. When the fungus on steamed rice was 8 days old the aërial mycelium was dense, fluffy, deep rose pink, jasper pink, phlox pink and pale hortense violet. The substratum was ochraceous orange; yellow ocher and antimony yellow.

When 17 days old, the mycelium became old rose to eugenia red and the substratum, light ochraceous buff. Cultures 38 days old were depressed in growth and cameo pink to thulite pink in color. On this medium, the fungus produced 0–, 1–, 2–, and 3–septate spores but the 2–, and 3–septate conidia were rare.

8. In young and old cultures on corn meal agar, the growth was thin, the hyphae at the edge of the slant radiating, and the growth glistening with very short, scanty, white aërial mycelia which, when examined under the microscope, were found to be very long chains of microconidia. Only the 0–septate spores were produced. The fungus did not change the color of the medium; it remained translucent and colorless.

9. Cultures 5 days old on potato cylinders were characterized by an aërial mycelium that was dense, loose, cottony, and white. When 7 days old it became dense, thick and orange pink. When 15 days old the mycelium appeared short, powdery and pale salmon buff and covered the whole cylinder. The fungus produced 0–, 1–, 2–, and 3–septate spores

10. The growth on steamed corn ear in the milk stage was evident after 2 days and it was characterized by dense, fluffy, white mycelium making the seed-coat of the corn appear light brown to bluish green in color. When 6 days old, the mycelium became cameo pink with pale rose purple areas. As the cultures became older, the growth became powdery and pale purplish vinaceous with bluish green areas. 0–, 1–, 2–, and 3–septate conidia were produced in this medium.

11. Cultures 5 days old on oatmeal agar had a somewhat slimy, submerged white, short, woolly mycelium. The colony as a whole was pale hortense violet. In plate cultures, indistinct zones of pale hortense violet, dirty white and light amparo purple were formed. When 13 days old, the mycelium became pale flesh-tinged with pallid bluish violet, the substratum being pallid violet. When 64 days old, salmon buff and bluish green sclerotia-like bodies were produced. On this medium, 0–, 1–, 2–, 3–, and even 4-septate conidia were produced, but the 3–septate was very abundant. The 4– and 5–septate conidia were rare.

The fungus was further grown in petri dishes and on slant cultures of various media. The principal media used were potato agar, nutrient agar, corn meal agar and oatmeal agar, to which various amounts of sugar (dextrose) and lactic acid were added.

The fungus grew rapidly and profusely on a number of these media, and in many cases it soon produced the characteristic violet-pink or purplish red color which was more brilliant than the color on the infected corn kernel in the field.

In five days colonies developed in all plates and slants although they differed from each other in size and color. On media containing dextrose the colonies showed faster development and produced rapid, fluffy and profuse growth, and deeper color than on media without dextrose. On agar media containing three drops of twenty-five per cent lactic acid, the growth was denser and better than those without dextrose.

The growth was profuse on steamed rice, lactose beef-extract agar, potato agar plus four per cent and eight per cent dextrose and on oatmeal agar. It was submerged and slimy on nutrient agar and scarce and thin on corn meal agar, water agar, and potato agar.

The growth increased in size on many culture media and the color grew deeper and deeper until finally it became dull and dingy. In cultures which contained neither acid nor dextrose, the growths were for the most part colorless, but eventually they became pale yellow. On potato agar there were slight traces of violet.

On old cultures of potato agar+two per cent dextrose, pionnotes and sporodochia were produced, while in old cultures on oatmeal, agar, sclerotial-like bodies were common.

As a whole, the substratum ranged from colorless to ochraceous buff and purplish violet.

For cultural studies, oatmeal agar seemed to be the most satisfactory medium for *Fusarium moniliforme* for the production of macrospores.

Taxonomy

An examination of the key to the sections of *Fusaria* by Wollenweber, Sherbakoff, Reinking, Johann, and Bailey (1925), shows that the Philippine kernel blast *Fusarium* belongs to the section Liseola, subsection Constrictum Wollenweber because the 0-septate conidia (microconidia) are in chains. The microconidia are thin walled and are fusoid-ovoid. The fungus does not produce chlamydospores. The substratum is colorless, ochraceous buff, and purplish violet.

According to Sherbakoff (1922):

> Among the Fusaria answering Sheldon's description of *Fusarium moniliforme* are several that differ from each other in more than one important character and are thus apparently different organisms. For this reason and because none of the previously established sections of the genus *Fusarium* has the characters of these corn fungi, a new section moniliforme is proposed for Fusaria which have: Macroconida of intermediate Roseum Elegans type, with very thin walls, mostly 3-septate; microconidia also in chains; no chlamydospores; color of substratum from none to violet.

Sheldon (1904) characterized *Fusarium moniliforme* as follows:

> Sporodochia sub-effuse, salmon pink, sporophores simple or branched, usually opposite, microconidia, continuous, oblong-ovoid, moniliform, 6-10 μ long; macroconidia falcate, acute, for the most part 3-septate, 25–40 μ long.

Reinking and Wollenweber (1927) characterize *Fusarium moniliforme* Sheldon as follows:

> Microconidia in chains or false heads formed in white to Isabela color aërial mycelium, spindle to ovoid in shape, 5 to 12 by 2.25–4 μ.
>
> Macroconidia delicate and slender, sickle-shaped, attenuate, pedicellate, scattered or in sporodochia or pionnotes, brownish white to orange cinnamon; mostly 3-septate, 30 to 36 by 3 to 3.5 (23 to 48 by 2.25 to 4) μ, fewer 1–, 4–, 5-septate; 1-septate, 12 to 18 by 2.25 to 3.5 μ; 4-septate, 37 to 53 by 3 to 3.5 μ; 5-septate, 43 to 66 × 3 to 3.5 μ, chlamydospores absent; sclerotia blue, stroma violet to ochraceous. Under certain conditions some cultures produce blue to almost black Gibberella-like sclerotia up to .5 mm.

The shape of the microconidia and macroconidia, predominance of the 3 septate macroconidia, absence of chlamydospores, and color of substratum of the Philippine kernel blast *Fusarium* are very much like those of *Fusarium moniliforme* Sheldon. The similarities of the two forms of *Fusarium* are so great that the Philippine kernel blast *Fusarium* is considered identical with *Fusarium moniliforme* Sheldon. In the size of the macro– and microconidia there is a slight discrepancy between the fungus under study and the *Fusarium moniliforme* Sheldon. This, however, may be due to the differences of media used, technique followed, and climatic conditions in the Philippines and in the United States. This slight discrepancy in size is not considered of taxonomic significance.

LIFE HISTORY IN RELATION TO PRODUCTION OF THE DISEASE

Pathogenicity

Field inoculation. To prove the pathogenicity of the *Fusarium* isolated from infected kernels, inoculation experiments were conducted on growing plants at different stages of ear-development in the following manner:

1. Water-suspension of conidia from pure culture was sprayed thoroughly on the silk and outer husks of:
    (a) Corn ears immediately upon their appearance on the stalks.
    (b) Corn ears as soon as the silk appeared.
    (c) Corn ears when the silk began to wither.
    (d) Corn ears with kernels at the milk stage.
    (e) Corn ears with kernels at the glaze stage.
    (f) Corn ears when fully mature.
2. Control ears of each method of inoculation were maintained and these were sprayed with sterile water.
3. All inoculated and check ears were bagged with paraffined paper bags with a piece of cotton saturated with water in each bag. The purpose of the wet cotton was to supply moisture necessary for spore germination and penetration.
4. All inoculations and checked ears were tagged and labeled fully.
5. At harvest time, the degree of infection of the ears inoculated at different stages of development was noted.

6. Reisolations were made and the inoculations were repeated.

7. Some of the representative kernels from the inoculated ears at different stages were planted in pots and germination and growth of the seedlings were noted.

The results of these inoculation experiments are given in tables 3 and 4.

Summary of the results of inoculation experiments. The results obtained from the field inoculation experiments (pl. II, fig. 1 and 2) may be summarized as follows:

1. Ears inoculated immediately upon their appearance on the stalks did not develop at all because of the premature rotting of the ears. The inner husks and the silk were held firmly to the cob by the fungous mycelium. The cobs and shanks were yellowish brown in color. Although the control ears did not produce grains because the bagging prevented pollination, nevertheless the cobs of these ears were sound, white and had no signs of discoloration whatsoever.

2. Ears inoculated as soon as the silk appeared produced the disease. The ears produced were nubbins and the kernels were characterized with numerous minute stripes causing the grains to appear dull and rough owing to cracking. A few of the kernels were split or cracked, pinkish and somewhat powdery in appearance. The cobs were rather yellowish-brown. The control ears also produced nubbins, owing to interfered pollination, but these ears had no symptoms or signs of the disease. The cobs were white and sound.

3. Ears inoculated when the silk began to wither produced kernels with numerous stripes. The cobs and shanks were discolored. The control ears were fully developed, with plump, bright, and sound kernels.

4. Ears inoculated at the milk stage developed ears of which only the kernels near the tip were affected. They presented the characteristic striping. Most of the kernels were burst or split, exposing the starchy endosperm. The infected kernels were reddish to purplish black in color. The control ears produced fully developed ears with thick, plump, bright, sound kernels with well developed germs, distinct horny endosperm and good shank attachment.

5. Ears inoculated at the glaze stage produced ears which showed infection by the disease. The kernels near the tips were affected showing minute stripes. The control ears did not show any sign of infection.

6. Ears inoculated when fully matured produced ears with very few affected grains; these were near the tips. The control ears were perfectly healthy.

The results of the inoculation experiments of the writer agree favorably with those of Moore (1924).

Germination test of the diseased seeds produced from the inoculation experiments. In order to determine the percentage of germination, uniformity of size, and growth of the seedlings, pots of uniform size were washed and filled with moist loam soil, and sterilized in the autoclave for about 120 minutes at 15-pounds' pressure. They were then allowed to cool. Each pot was planted to 50 surface-sterile (kernels were soaked in 1:1000 mercuric chloride solution for two minutes) diseased seeds of corn with varying degrees of infection. They were then observed and compared with the control seeds which were taken from healthy ears. The results of this experiment are shown in table 5.

In another experiment the percentage of germination, uniformity of size and growth of the seedlings and the color of the old kernels after germination were studied as follows:

Petri dishes of uniform size were washed, the bottoms covered with cotton, wet and sterilized in the autoclave for 15 minutes at 15-pounds' pressure. They were then allowed to cool, kept moist with sterile water and in each were germinated 10-surface sterile seeds of varying degrees of infection. The seedlings were observed and compared with a control, noting particularly the change in color of the old kernels after germination.

The results of this experiment are shown in table 6.

As shown in table 5 the infected kernels, when planted, gave a low percentage of germination, uneven stand, and weak growth of the seedlings.

The cracked kernels very seldom germinated. When they did the seedlings began to wilt at the end of four or five days because of the complete rotting of the old kernels and stems just a few centimeters above the ground. When examined it was noted that the seedlings were covered with the dense, pinkish growth of mycelium of the causal fungus.

The writer further noted the difference in the date of germination between the control and infected kernels.

Method of living between seasons

From the writer's experiments it was noted that the fungus gains entrance into the kernels through the silk. It invades all parts of the kernels and its mycelium penetrates intercellularly and intracellularly. On account of this growth in the kernels the fungus becomes seed-borne. By planting infected kernels, the disease is reproduced in the field.

In very advanced stages of rotting, microconidia and macroconidia are produced. Judging from their nature these spores are disseminated by wind as soon as the cracking or splitting of the kernels takes place.

Valleau (1920) and others were able to isolate the organism from infected roots and stalks of corn. When infected roots and stalks of corn rot, the fungus establishes itself in the soil and the disease is produced if corn is planted in such Fusarium-infected fields.

The mycelium in the seeds, soil, and air forms sources of inocula for field infection.

Sources and method of infection

The writer's results corroborate those of other authors who report that *Fusarium moniliforme* is a seed-borne organism.

Selby (1918) states that, primarily, the disease may be regarded as caused by a soil-inhabiting fungus which attacks the rootlets, thence invading the larger roots and stem of the corn plant. Once in the stem, it may advance upward and even grow out in the air, causing the pink mold of corn.

According to Wenholz and Darragh (1927) infection of the stalk may take place from the fungi in the soil or from the mycelium present in the seed. Infection of corn results in the rotting of the roots and easy lodging of the stalk. Wenholz and Darragh further state that it is seldom found that if the stem is diseased that the roots are healthy; while if the roots are diseased the fungus spreads, in most cases, at least, through the lower part of the stem. The kernels carry internally the mycelium of the fungus and in this form of infection the disease is likely to make more headway in the plant than if infection has to take place through the root tissue by chance contact with the fungus in the soil. According to these authors the stem may also become infected through the tender ear shoots behind the leaf sheaths at the nodes, and infection may spread from these points or from the base of the plant to the ear, or the ears when young and tender may become infected directly by the spores flying about the field.

Manns and Adams (1923) found that the fungus enters not only with the seed by seminal infection, but also that the undeveloped shoots in the axils of the leaves are probably responsible for some of the infection in the field.

In secondary infection the avenue of entrance is through the silk from the spores in the air. Van Der Bijl (1914) in South Africa considers that normally infection takes place through the stigmas. The writer used spore-suspension sprayed upon the ears at different stages and secured infection of the kernels and ears through the silk.

The fungus may also infect the corn plant through injuries of the husks and shanks.

WEATHER AND SOIL CONDITIONS IN RELATION TO THE OCCURRENCE AND SEVERITY OF FUSARIUM EAR ROT

According to Wenholz and Darragh (1927) maize seedlings are readily attacked at low temperatures but less seriously infected at temperatures above 23.8°C. (75°F.). These authors and also Dickson (1923), Eckerson and Dickson (1923), and Dickson and Holbert (1927) state that the influence of temperature on the development of the seedling blight of maize is primarily a host response.

Burrill and Barrett (1909) found that corn on the rich, black land of the corn belt of the United States is more subject to diseases than that grown on higher and thinner soils. These authors report that warm moist weather favors the development of ear rots in general and the production of spores of the causal fungi. From the data collected and reports sent in by corn growers, these authors state that, as a rule, ear rot is more prevalent and destructive in fields planted successively to corn than in those on which a good system of rotation is practiced. Holbert, Burlison, Koehler, Woodworth and Dungan (1924) state that on soils lacking lime and phosphorus the reduction in total yield frequently has been pronounced, and, obviously, the roots, stalks, and ears of some strains of corn are very susceptible to rot by *Fusarium moniliforme.*

The writer noted that the severity of the disease is influenced by excessive moisture and low temperature. There were more infected ears during the wet season harvest than in the dry season crop.

A GENERAL CONSIDERATION OF THE CONTROL MEASURES

Exterminatory measures

Whenever there is slight infection of corn by the *Fusarium* disease, and diseased stalks or otherwise lodged or broken stems occur in a corn field these should be pulled up and piled and burned so as to destroy the mycelium and spores of the causal fungus and prevent it from multiplying.

Ears with shredded or discolored shank-attachments should be treated likewise, if they are not good for stock-feeding purposes.

Sanitary and cultural methods

When the time for planting corn comes, the field should be cleaned thoroughly by plowing under stubble or by collecting it in piles and burning it.

The seed for planting should be selected from disease-free ears which have thick, plump, bright and clean kernels, with well-developed germs and a distinctly horny endosperm and complete shank-attachments. The most practical method of securing good seed is by careful seed-selection while the corn plants are in the field.

Holbert and Hoffer (1920) recommend selecting disease-free ears for seed from normally matured ears, from the best normal stalk, and from the best varieties available. The description of a good seed ear is given by Holbert, Burlison, Koehler, Woodworth and Dungan (1924).

Wenholz and Darragh (1927) also recommend that sound ears should not be selected from diseased, prematurely ripened, easily pulled ear, lodged or broken and discolored shanks. The ears containing any split, moldy or dark colored, pinched or badly filled grain should be rigorously avoided. Any split kernel, or any lack of plumpness or looseness of the grain on the cob should be regarded as highly suspicious. Deep set, dull colored, soft starchy grain, with rough dent has a great tendency to carry the disease or to produce plants susceptible to the attack of the disease.

The selected seed should be tested first for germination to know the presence or absence of disease and the vigor and lack of vigor of the seedlings which will develop. It is said that a germination test is generally a reliable index of the vitality and productiveness of corn.

All the ears showing infection and lack of vigor should be discarded.

The seeds selected should be cured, dried thoroughly, and stored properly.

Valleau (1921) states that thus far no disease-free seed has been obtained by the method of selection. The results of his experiments indicate that infection takes place before the early dough stage, and probably occurs through the silk and is a result of infection of the exposed silk mass with *F. moniliforme.* His attempts to control by seed-treatment have given negative results.

Smith and Hoffer (1921) report field selection from apparently healthy stalks, artificial drying by heat immediately after harvesting the ears, and testing seed ears to reduce the amount of seed infection.

For infection coming from the soil, seed-treatment may be of importance because it has been shown that the excess of the fungicide which covers the kernels sterilizes the soil immediately around the seeds.

Reinking (1918) recommends not to plant too thickly so as to allow plenty of aëration.

As far as it is known, the kernel rot *Fusarium* attacks only corn and sugar cane in the Philippines; hence all other plants would seem to be of value in crop rotation. The time necessary to withdraw corn and sugar cane from the series has not been worked out by the writer.

Seed-treatment experiments. Wenholz and Darragh (1927) in Australia report that some of the mercury-phenol compounds have possibilities in the treatment of seed carrying internal-fungi.

Reddy, Holbert, and Erwin (1926) found increased yield from treated diseased seeds but a reduction in yield in treated disease-free seeds. Reddy and Koehler (1918) using corn from well-selected nearly disease-free seed noted beneficial effects by treatment when early planting was followed by a period of cold and wet weather.

Calma, Paderna, and Palo (1929) found that the kernels suspected of carrying the *Fusarium* and molds treated with weak aqueous solutions of Germisan, formalin, Uspulum, Semesan and mercuric chloride gave a higher percentage of germination and better growth of seedlings in the wet and dry season plantings and controlled the seed-borne diseases.

Kiesselbach (1927), Ames and Casanova (1927), Melhus, Reddy, Raleigh and Burnett (1928) and Kiesselbach (1930) found that the dust and liquid organic mercury disinfectants were of greater benefit to the infected seeds than to the ones disease-free.

Sherbakoff (1924) found that corn seed, when effectively treated against *F. moniliforme,* did not give any better yield than the untreated seed of the same corn. He observed the checks to give slightly better yield than the treated seed. He states that contamination of corn seed with mold has no effect upon the yield owing to the fact that either *F. moniliforme* is nonpathogenic to corn roots or that soil contamination with the fungus is so thorough and effective that seed freedom from it is of no consequence.

Holbert, Reddy, and Koehler (1926) found seed-treatment with various fungicides to improve greatly both the yield and quality of dent corn grown from seed infected with *Diplodia zeae* and *Gibberella saubinetii*, but not corn from *F. moniliforme* infected and scutellum-rotted kernels.

Although the organic mercury compounds show no significant effect upon germination, stand, growth rate, crop vigor, yield or quality of product, they are possible control for root, stalk, and ear rot diseases when it is impossible to secure nearly disease-free seed.

Reddy and Koehler (1928) found that varieties of corn differ in the degree to which they are benefited by the seed treatments, and Orton (1927) reports that the rate of permeability of seed-coats to each of the mercury compounds varies with the corn varieties.

The writer's results on treatment of corn kernels with dusts may be summarized as follows:

1. Practically, all kernels treated gave higher percentage of germination, better growth rate, and greater vigor than those of the control.

2. From the writer's treatment and germination experiments Semesan Jr. proved to be the best, followed by P-M-A, Ceresan and K-I-K, while Germisan as dust had the poorest effect.

3. The difference between the writer's results and those of Calma, Paderna, and Palo (1929) is attributed to the method of treatment.

4. The results obtained from the germination studied showed that dust treatments of Fusarium-infected corn kernels with Semesan Jr.[3], P-M-A.[4], Ceresan[5], K-I-K[6] and Germisan[7] at the rate of two to three ounces (3 oz = 85 + grams) of the dust to one bushel (35.24 liters) of the dry seed are effective for the control of the disease. No study was made on the effect of the treatment upon the yield of corn.

5. The practicability of the organic mercury dust treatments under Philippine field conditions was not studied in the present work.

Varietal resistance

Moore (1924) states that in New Jersey flinty types of corn are the most resistant to root and ear rot diseases. According to Wenholz and Darragh (1927), if two resistant strains are crossed, the resultant hybrid willl be resistant to the disease.

According to Holbert, Burlison, Koehler, Woodworth, and Dungan (1924), various strains of corn differ widely in their susceptibility to *Fusarium moniliforme* as an ear rot producing organism. They state that some strains have been very susceptible, frequently from 15 to 25 per cent of the grain being damaged by *Fusarium* ear rot alone, and that other strains growing in adjacent plots have been practically immune to *Fusarium* ear rots.

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[3], [4], [5], [6] From the Bayer-Semesan Co., Inc., Wilmington, Delaware, U.S.A.

[7] From Saccharin-Fabrik in Germany.

In the College of Agriculture at Los Baños, Laguna, all the varieties of corn planted during the years covered by the writer's experiments seem to be equally susceptible to the disease. No work was done to determine whether or not the harder or flinty varieties are more resistant to the disease than the softer ones.

Valleau (1921) states that differences in the time of death of the plants of a given variety under field conditions are dependent upon differences in resistance of the plants to root rot, and are not the result of planting diseased or disease-free seed. He found that ears may be graded according to resistance by growing seedlings in a sand box and noting the time required for the individual seedling to root on the surface of the sand.

According to Holbert, Burlison, Koehler, Woodworth, and Dungan (1924), disease resistance is generally associated with seed from apparently healthy plants that show vigor and freedom from disease on the germinator and that is horny in composition. These authors state that resistance to certain of the corn rot diseases can be maintained by constant selection.

Field selection of seed from the longest lived plants may prove a means of obtaining seed of a high degree of resistance.

SUMMARY

1. The *Fusarium* disease of corn occurs in the Philippine Islands where it was first reported in 1918.

2. The species of *Fusarium* which causes the disease of corn also attacks sugar cane. In other places conifers, wheat, barley, rye, oats, pseudo-stems and dead floral parts of banana, besides sugar cane, and nearly all varieties of corn are infected by the causal fungus of corn rot.

3. Some of the common names given to the *Fusarium* disease of corn are: corn mold, kernel blast, kernel rot, dry rot, pink rot, and splitting disease of the corn kernels. In the Philippines the Tagalog names for the disease are *namumutok* and *namumusangsang*.

4. The *Fusarium* causing the disease of corn under study was first described in 1904 in Nebraska by Sheldon as *Fusarium moniliforme*. Since that time, this species has been known to be a parasite of corn and various other plants.

5. The disease seems to be widely distributed in the United States, Australia (especially N. S. W.), South Africa, Central America, and the Philippines. Probably it is found elsewhere.

6. The most common symptoms exhibited by this disease on seedling corn are yellowing and wilting of the leaves and rotting of the roots, which result in the death of the seedlings. On the ears the symptoms are the

production of stripes on the grain and the cracking or blasting of the kernels causing typical kernel rots and the discoloration of the seed coats.

7. In pure culture the fungus causing this disease produces from scanty to medium dense and from dirty white to deep rose pink and pale hortense violet aërial mycelium, and slimy, light buff submerged mycelium. It produces oblong-ovoid microconidia in long chains and sickle-shaped pionnotal and sporodochial macroconidia. The fungus grows rapidly and profusely on a number of media and soon produces a growth with characteristic violet pink or purplish red color which are of more brilliant hues than those on the infected corn kernels. On media containing dextrose, the fungus grows faster and more profuse and deeper colored than on those without sugar. The growth is profuse on steamed rice, lactose-beef-extract agar, potato agar plus four and eight per cent dextrose, and on oatmeal agar. It is submerged in nutrient agar and thin on cornmeal agar, water agar, and potato agar. The fungus changes the color of the substratum from colorless to ochraceous buff or purplish violet.

8. The fungus causing the corn disease in the Philippines is identified with *Fusarium moniliforme* Sheldon. The organism belongs to section Liseola Wollenweber, Sherbakoff, Reinking, Johann, and Bailey; section moniliforme Sherbakoff; subsection Constrictum Wollenweber.

9. The infection caused by the fungus is inversely proportional to the maturity of the kernels, that is, the older and harder the grains, the less is the degree of infection and the slower is the development of the disease.

10. The sources of primary infection are the soil and diseased seeds. Infection of the ears occurs through the silk.

11. The *Fusarium* kernel blast is a seed-borne disease of corn.

12. The disease may be controlled by seed selection, crop rotation and by collecting and burning the infected stalks, husks, stubble, etc. The practicability of dust treatments, though effective against the Philippine corn *Fusarium* in germination studies was not studied under field conditions.

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TABLE 1

The amount of growth of the Philippine corn Fusarium in plate cultures on different media and the color of the growth produced on each medium

MEDIA USED	AGE OF CULTURE WHEN EXAMINED	GROWTH AND COLOR PRODUCED	AVERAGE DIAMETER OF COLONY
	days		*mm.*
1. Potato agar	5	Growth submerged with scanty white aërial mycelium	46
2. Potato agar plus two per cent dextrose	5	Growth dense, with short, twisted, pale hortense to phlox pink aërial mycelium	48
3. Potato agar plus four per cent dextrose	5	Aërial mycelium medium dense short, twisted, pale hortense violet to cameo pink	54
4. Nutrient agar	5	Mycelium submerged slimy, and light buff	45
5. Lactose–beef–extract agar	5	Aërial mycelium short, twisted, dense and white	61
6. Corn meal	5	Aërial mycelium dense, fluffy, pale hortense violet to venetian pink	35
7. Steamed rice	5	Growth dense, fluffy, pale hortense violet to phlox pink	62
8. Oatmeal agar	5	Mycelium submerged except a few aërial of pale hortense violet	45
9. Corn meal agar	5	Growth thin and white or colorless	46

TABLE 2

Comparative growth and color produced of the Philippine corn Fusarium on slant media to which dextrose and a few drops of 25 per cent lactic acid had been added.

MEDIA USED	AGE WHEN EXAMINED	COLOR OF GROWTH	CHARACTER OF GROWTH
	days		
1. Nutrient agar	5	White	Submerged and slimy
2. Nutrient agar + three drops of lactic acid	5	Pale congo pink	Fluffy
3. Nutrient agar + eight per cent dextrose	5	Chatenay pink to cameo pink	Submerged with fluffy aërial mycelium.
4. Potato agar	5	White	Submerged with scanty aërial mycelium.
5. Potato agar + three drops of lactic acid	5	Pale vinaceous	Fluffy
6. Potato agar + eight per cent dextrose	5	Cameo pink to light vinaceous pink	Abundant and fluffy
7. Corn meal	5	Cameo pink to rosaline pink	Abundant and fluffy
8. Corn meal + three drops of lactic acid	5	Pale lavender violet	Scanty
9. Corn meal + eight per cent dextrose	5	La France pink to orient pink	Abundant and fluffy
10. Oatmeal agar	5	Livid pink	Submerged with few aërial mycelium
11. Oatmeal agar + three drops of lactic acid	5	Light sofrano pink to cameo	Submerged with short aërial mycelium
12. Oatmeal agar + eight per cent dextrose	5	Cameo pink to phlox pink	Submerged with short aërial mycelium

TABLE 3

Inoculation with the corn blast Fusarium of corn ears at different stages of development showing percentages of infection resulting therefrom

STAGE OF CORN-EAR FORMATION WHEN INOCULATED	NUMBER OF EARS USED		NUMBER OF EARS INFECTED		NUMBER OF EARS NOT INFECTED		PERCENTAGE OF INFECTION		REMARKS
	Inoculated	Check	Inoculated	Check	Inoculated	Check	Inoculated	Check	
1. Immediately upon their appearance on the stalks	10	5	10	0	0	5	100	0	Cob and shank were rotted and discolored.
2. As soon as the silk appeared	10	5	10	0	0	5	100	0	Inner husks and silk were held firmly to the cob by the fungous mycelium.
3. When the silk began to wither	10	5	10	0	0	5	100	0	Inner husks and silk were held firmly to the cob by the fungous mycelium.
4. Milk stage	10	5	9	0	1	5	90	0	Kernels, especially at the tip, were blasted.
5. Glazed stage	10	5	9	0	1	5	90	0	The kernels were characterized by minute stripes.
6. When fully mature	10	5	7	0	3	5	70	0	Very few kernels had the characteristic stripes.

TABLE 4

Inoculation with the corn blast Fusarium of corn ears at different stages of development showing percentages of infection resulting therefrom

STAGE OF CORN-EAR DEVELOPMENT AT TIME OF INOCULATION	NUMBER OF EARS USED		NUMBER OF EARS INFECTED		NUMBER OF EARS NOT INFECTED		PERCENTAGE OF INFECTION		REMARKS
	Inoculated	Check	Inoculated	Check	Inoculated	Check	Inoculated	Check	
1. Immediately upon their appearance on the stalks	10	5	10	0	0	5	100	0	Ears did not develop grains. Rotted.
2. As soon as the silk appeared	15	5	15	0	0	5	100	0	Ears were nubbins.
3. When the silk began to wither	15	10	14	0	1	10	93.34	0	Small ears but full.
4. Milk stage	10	5	9	0	1	5	90	0	Fully developed ears.
5. Glazed stage	10	5	7	0	3	5	70	0	Fully developed ears.
6. When fully mature	10	5	6	0	4	5	60	0	Ears appeared sound.

TABLE 5

Showing the result of the germination tests of diseased kernels in sterile soil

KERNELS USED		NUMBER OF KERNELS WHICH DID NOT GERMINATE	NUMBER OF KERNELS WHICH GERMINATED	PERCENTAGE OF GERMINATION	REMARKS
condition	number				
1. Healthy kernels. .	50	0	50	100	Seedlings were uniform in height and growth.
2. Slightly diseased with very few stripes.	50	1	49	98	Nearly uniform in height and growth.
3. Striped kernels. . .	50	7	43	86	Not of the same height and stand.
4. Partly cracked kernels.	50	19	31	62	Not of the same height and stand.
5. Badly cracked kernels.	50	47	3	6	The seedlings showed very great difference in height and stand.

TABLE 6

Showing the result of the germination tests of diseased kernels in Petri dishes

KERNELS USED		NUMBER OF KERNELS WHICH DID NOT GERMINATE	NUMBER OF KERNELS WHICH GERMINATED	PERCENTAGE OF GERMINATION	REMARKS
condition	number				
1. Healthy kernels. .	10	0	10	100	The seedlings were nearly of the same height and had no discoloration whatsoever.
2. Slightly diseased kernels with very few stripes.	10	0	10	100	Not of the same height; part of each kernel was pinkish brown in color.
3. Striped kernels . .	10	1	9	90	Not of the same height; brownish in color.
4. Partly cracked kernels.	10	3	7	70	The kernels were covered with medium dense growth of mycelium.
5. Badly cracked kernels.	10	9	1	10	The kernels were all covered with pinkish growth of the fungous mycelium. The seeds turned pinkish-brown to reddish violet.

ILLUSTRATIONS

PLATE I

Fig. 1a. Infected ear of pop corn showing the blasted kernels and their distribution on the ear.

Fig. 1b and 2. Infected Calauan Yellow Flint maize ears showing the blasted kernels in a more advanced stage exposing the starchy endosperm.

PLATE II

Fig. 1. Infected ears of Calauan Yellow Flint corn showing the different degrees of infection resulting from inoculation experiments in the field to prove the pathogenicity of the causal fungus.

(1a). Ear resulting from the inoculation of the corn ears immediately upon their appearance on the stalks.

(1b). Ear resulting from the inoculation of corn ears as soon as the silk appears.

(1c). Ear resulting from the inoculation of corn ears when the silk begins to wither.

(1d). Ear resulting from the inoculation of corn ears with kernels at the milk stage.

(1e). Ear resulting from the inoculation of corn ears with kernels at the glaze stage.

(1f). Ear resulting from the inoculation of corn ears when fully mature.

Fig. 2. Normal ears of corn produced from control plots for the inoculated plants.

(2a). Ear resulting from merely spraying with sterile water and bagging the corn ears immediately upon appearance on the stalks. Note that although the cob has no kernels, nevertheless it is clean and healthy.

(2b). Ear resulting from merely spraying with sterile water and bagging the corn ears as soon as the silk appears.

(2c). Ear resulting from merely spraying with sterile water and bagging the corn ears when the silk begins to wither.

(2d). Ear resulting from merely spraying with sterile water and bagging corn ears with kernels at the milk stage.

(2e). Ear resulting from merely spraying with sterile water and bagging the corn ears at the glaze stage.

(2f). Ear resulting from merely spraying with sterile water and bagging the corn ears when fully mature.

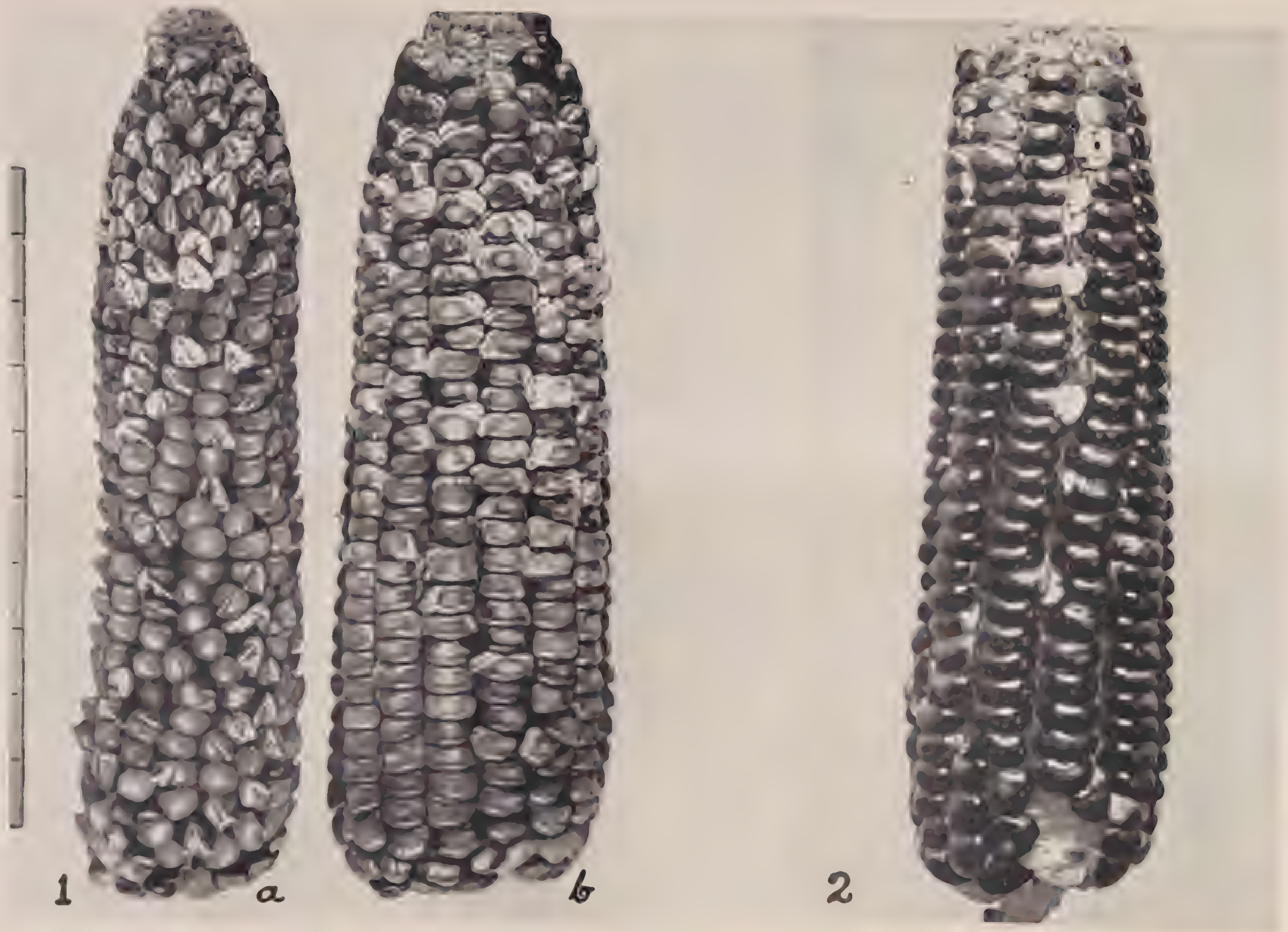
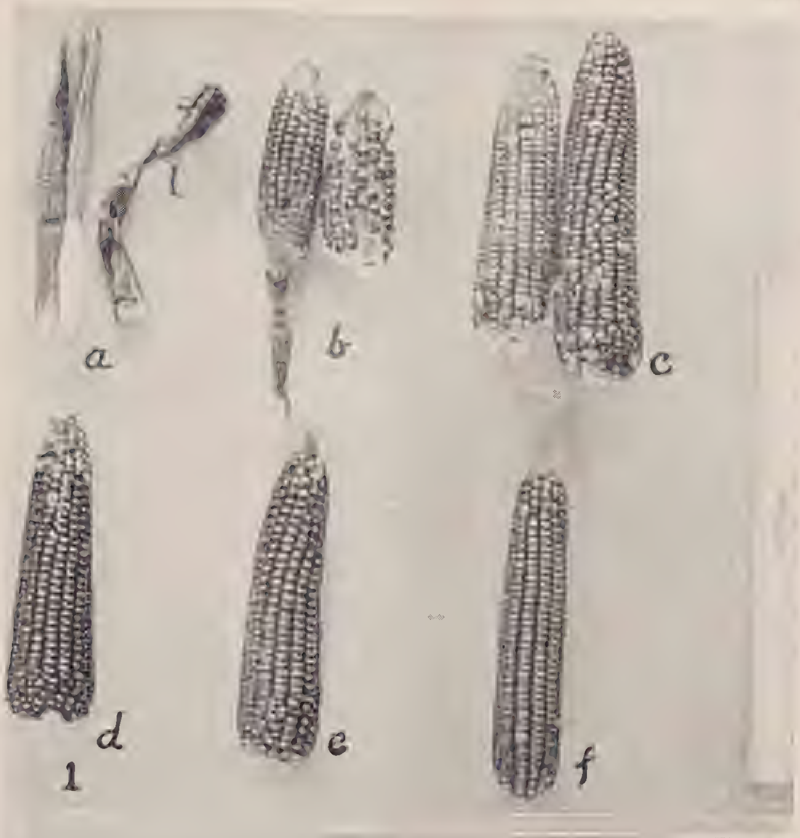


Plate I



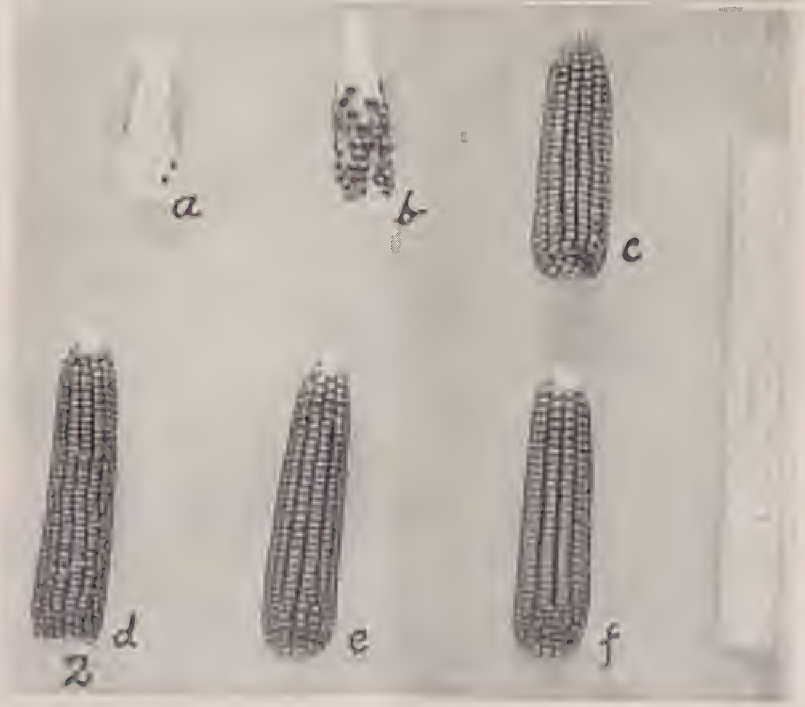


PLATE II

A STUDY ON THE EFFECT OF VARYING AMOUNTS OF COPRA MEAL ON THE GROWTH OF SHOTES[1]

CORNELIO RAMOS GALLARDO

WITH THREE CHARTS

The object of this experiment was to determine the effect on growing pigs of various amounts of copra meal added to a basal ration consisting of rice bran and corn.

The work was conducted at the College of Agriculture. Los Baños. It was begun on September 18, 1927, and closed on September 30, 1928.

From past experiments on copra meal in rations carried out in this College, the following results were reported.

Allas (1924) found that copra meal mixed with rice bran with a carbonaceous forage produced cheaper pork than copra meal and corn with the same forage.

Taleon's result (1924) shows that chickens receiving copra meal gained in weight more than those that received no copra meal.

Sulit (1926) using guinea pigs as material recorded that 37 per cent copra meal in the feed gave good results, but when present in 75 to 85 per cent, it had a deleterious effect.

Crucillo (1926) stated that 20 to 30 per cent copra meal in the ration for laying hens gave the best results.

MATERIALS AND METHODS

Materials

Animals. The pigs used in the first test were twenty barrows and five gilts bought in the market at Calamba, Laguna. The pigs were about six months old at the beginning of the experiment. They were grade Berkshire pigs, uniform in size and rather spare in condition.

In the second experiment ten animals were used—eight barrows and two gilts. Their average age was about six months at the beginning of the experiment. They were Berkshire-Native grades.

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[1] Thesis presented for graduation, 1929, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 311; Experiment Station contribution No. 653. Prepared in the Department of Animal Husbandry under the direction of Dr. Mariano Mondoñedo.

Feeds. In the experiments, copra meal, rice bran, and corn were used to make up the ration. The following rations were used in the first experiment:

Feeds	*Lot I*	*Lot II*	*Lot III*	*Lot IV*	*Lot V*
Corn	33.3 parts	30.0 parts	26.6 parts	23.3 parts	20.0 parts
Rice bran	66.7 parts	60.0 parts	53.4 parts	46.7 parts	40.0 parts
Copra meal	0.0 part	10.0 parts	20.0 parts	30.0 parts	40.0 parts
Total	100.0 parts	100.0 parts	100.0 parts	100.0 parts	100.0 parts

In experiment II the rations used for the two lots were similar to those given for lots IV and V in experiment I.

To each of these rations one per cent of equal parts of common salt and corn-cob charcoal was added as a mineral mixture.

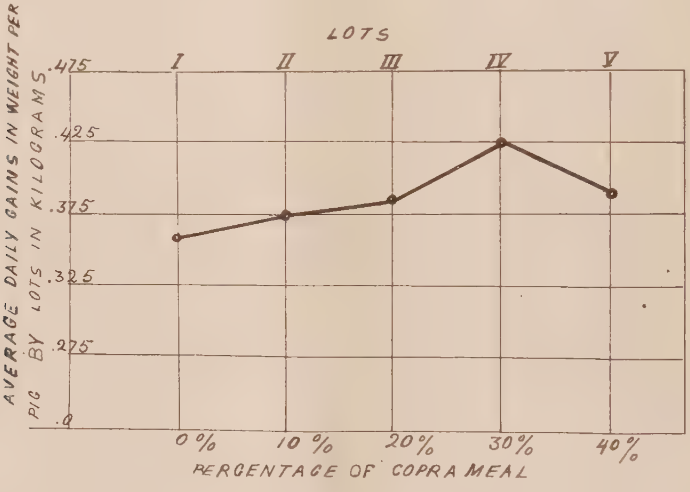

CHART 1

Methods

Feeding. The pigs in all the experiments were hand fed twice daily, allowing them all they would easily consume.

Weighing. The animals were weighed for three consecutive days. The average of these three weighings were used as the initial weights. The final weights were obtained in a similar manner.

Allotment. In experiment I five lots of five pigs each were used. In experiment II two lots with five pigs in each were used. Experiment II was conducted to verify the results obtained from the best two lots (IV and V) of experiment I.

Care and management

Experiment I. This experiment was started when camote (sweet potato) pasture was plentiful. The animals had two pasture lots, one-fourth of a hectare in each, reserved for them. Culape, *Paspalum conjugatum,* formed the greater part of the vegetation in the pasture lots. The pastures were used in rotation. The animals were kept in one pasture lot as long as there was camote or grass in sufficient quantities. When these were exhausted the animals were put in the other pasture which had in the meantime grown grass. Rotation went on in this fashion until the end of the experiment.

Experiment II. The pigs were dry lot fed, as green grass was not available at the time. However, they were allowed the run of the same two pasture lots used in experiment I. These lots were almost bare of vegetation at the time.

The animals in each of the two trials were together in the same pasture, except at feeding time, when they were driven into separate pens and fed by lots. On stormy days, the pigs were kept in the hog house.

RESULTS AND DISCUSSIONS

Observations

Experiment I. Lot I (no copra meal) of experiment I took the shortest time to eat their meals, but they were the slowest gainers.

The pigs in lot IV (30 per cent copra meal) were the most vigorous animals among the five lots. They always had a good appetite.

Experiment II. Most of the pigs in both lots had sore eyes during the last two weeks. This was evidenced by the presence of lachrymal discharges and congestion of the conjuctiva. This trouble was probably caused by lack of pasture.

Discussions

Experiment I. It may be noted in table 1 and in chart 1 that corresponding to the increase in the percentage of copra meal in the rations from lot I (no copra meal) up to lot IV (30 per cent copra meal) there was also a corresponding improvement in the ability of the pigs in the different lots to make gain in weight more rapidly. However in lot V, with 40 per cent copra meal, there was a decrease in the rate and amount of gains made. The results showed that about 30 per cent copra meal is the optimum amount necessary to supplement corn and rice bran.

Table 1 shows no very marked difference in the average gains made by the lots up to lot IV, but the growth curve as shown in chart 1, rises gradually up to lot IV from which point the gain in weight falls. The gradual increase in gain in weight of the pigs in the first three lots may be explained by copra meal being a good supplement (it contains 17.27 per cent protein), but it is unpalatable and when used in a quantity over 30 per cent of the ration the feed mixture becomes unpalatable.

As indications of the unpalatability of copra meal the following behavior of the different lots was observed:

In lot I with no copra meal in their ration all the pigs consumed their feeds within the shortest time recorded.

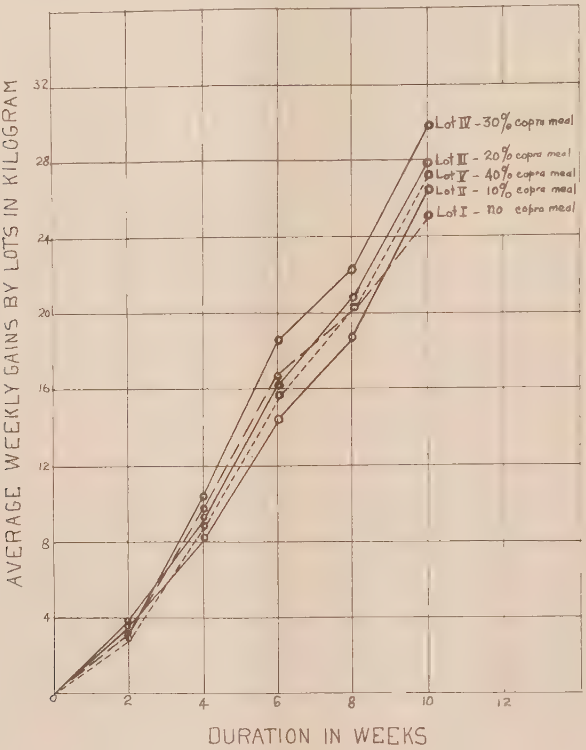

Chart 2

Pigs in lots IV and V, particularly in V with 40 per cent of copra meal, took the longest time to finish their meals. They invariably stirred their feed with their snouts and ate only a little at a time. Frequently they tipped the trough over. When turned out on pasture they grazed voraciously, showing that their ration had not satisfied them. When given the chance, the pigs would eat the kernels of corn first, and only when there was no more to be had would they eat the copra meal. Eating in this way they wasted much feed through spilling and by leaving feed in the trough.

Might it not be that the toxic and constipating effects which have always been attributed to copra meal are not due to the presence of toxic principles but to irregularities resulting from the unpalatability of the feed containing copra meal? When the pigs are forced to subsist on a ration that is not palatable, as one containing a large proportion of copra meal, they, for periods of some length, eat little or none of it. Some animals when their hunger becomes unbearable consume at irregular intervals large quantities of the rations or other available feed that they would ordinarily avoid. These irregularities may cause diarrhea and other intestinal disturbances, which lead to the conclusion that copra meal contains toxic properties. As a matter of fact, no toxic substance in copra meal has been isolated. In the light of the present observations it would seem that all the symptoms of a diseased condition observed in animals fed rations containing a large proportion of copra meal could be explained on the basis of disturbed feeding and digestion, caused by the unpalatability of the ration.

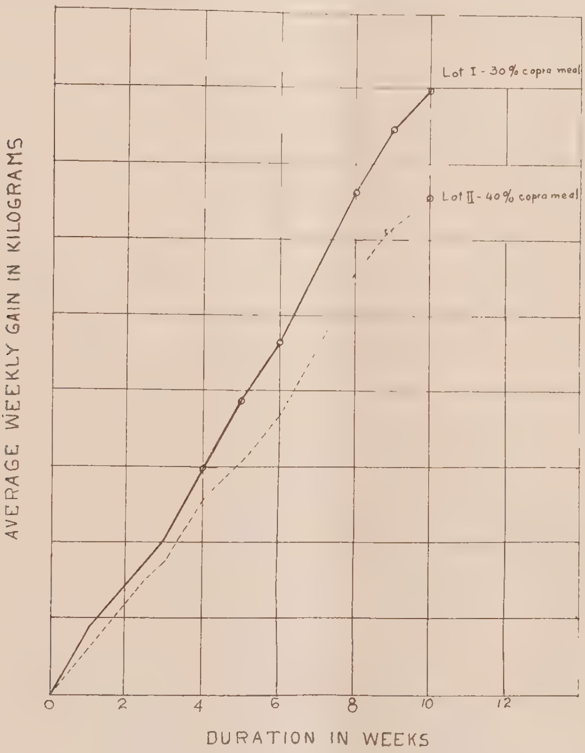

CHART 3

From the point of view of feed consumption, there was practically no difference in the amount required by each lot for a given unit of gain; each required about four kilograms of feed to produce one kilogram gain. Chart 2 shows the average weekly gains in weight made by lots in experiment I.

Experiment II. As may be recalled, this experiment was conducted to verify the results obtained from the best two lots of experiment I. The results presented in table 1 and chart 3 show that lot I which had 30 per cent copra meal was decidedly superior in every respect to lot II with 40 per cent copra meal; that is, in the amount, rate, and economy of gains. The daily gain of a pig in lot I was 0.456 kgm.; in lot II it was 0.373 kgm.; that is, lot I was 23 per cent more efficient than lot II. In economy of gain, lot I required 4.954 kgm. of feed to make one kgm. gain, while lot II required 5.313 kgm. This result differs from that of experiment I in which lot V was slightly more economical in gain than lot IV. This difference may be accounted for by the fact that in this experiment the pigs were on dry lot while in experiment I they were in pasture. Because of the higher nitrogenous ration in lot II, it appears that less of the nutrients in this lot were assimilated than in lot I. Chart 3 shows the average weekly gains made by lots in experiment II.

SUMMARY OF CONCLUSIONS

1. The gain in weight of pigs from six to nine months of age increased as the proportion of copra meal as a supplement to corn and rice bran increased up to 30 per cent; from which point the gain curve courses downward.
2. The greater amount of feed necessary to produce one kilogram of gain with pigs in lots I and II of experiment II, than was required in lots IV and V of experiment I, was owing to the absence of pasturage in the lots of experiment II.
3. The amount of grain feed required to make a kilogram gain with pigs in experiment I is approximately four kilograms. In experiment II the amount is approximately five kilograms.
4. Copra meal, according to observation, increases the unpalatability of the ration as its proportion is increased.
5. Besides the unpalatability of the ration in which 40 per cent copra meal was present, it was observed that the pigs were constipated; no symptoms of poisoning were noted.

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TABLE 1

Summary of results in each lot in experiments I and II

RATION:	EXPERIMENT I					EXPERIMENT II	
	Lot I	Lot II	Lot III	Lot IV	Lot V	Lot I	Lot II
CORN	33.3 parts	30.0 parts	26.6 parts	23.3 parts	20.0 parts	23.3 parts	20.0 parts
RICE BRAN	66.7 parts	60.0 parts	53.4 parts	46.7 parts	40.0 parts	46.7 parts	40.0 parts
COPRA MEAL	0.0 parts	10.0 parts	20.0 parts	30.0 parts	40.0 parts	30.0 parts	40.0 parts
Number of pigs	5	5	5	4[a]	5	5	5
Duration of experiment	70 days	70 days	70 days	70 days	70 days	70 days	70 days
Total initial weight	124.0 kgm.	120.8 kgm.	123.03 kgm.	105.0 kgm.	123.1 kgm.	177.7 kgm.	175.7 kgm.
Average initial weight	24.8 kgm.	24.16 kgm.	24 66 kgm.	26.25 kgm.	24.62 kgm.	35.54 kgm.	35.14 kgm.
Total final weight	249.3 kgm.	252.9 kgm.	257.0 kgm.	224.5 kgm.	259.4 kgm.	337.6 kgm.	306.3 kgm.
Average final weight	49.86 kgm.	50.88 kgm.	51.4 kgm.	56.13 kgm.	51.88 kgm.	67.52 kgm.	61.26 kgm.
Total gain	125.3 kgm.	132.1 kgm.	133.7 kgm.	119.5 kgm.	136.3 kgm.	159.9 kgm.	130.6 kgm.
Average gain per pig	25.06 kgm.	26.42 kgm.	26.74 kgm.	29.88 kgm.	27.26 kgm.	31.98 kgm.	26.12 kgm.
Average daily gain per pig	0.358 kgm.	0.377 kgm.	0.382 kgm.	0.427 kgm.	0.389 kgm.	.456 kgm.	0.373 kgm.
Total grain feed consumed	510.5 kgm.	526.0 kgm.	511.6 kgm.	484.0 kgm.	532.8 kgm.	793.20 kgm.	693.90 kgm.
Total cost of grain consumed	₱34.54	₱35.46	₱34.34	₱32.36	₱35.48	₱53.48	₱46.21
Average daily grain per pig	1.459 kgm.	1.502 kgm.	1.462 kgm.	1.729 kgm.	1.533 kgm.	2.266 kgm.	1.982 kgm.
Grain feed consumed to produce 1 kgm. gain	4.074 kgm.	3.982 kgm.	3.826 kgm.	4.05 kgm.	3.909 kgm.	4.954 kgm.	5.313 kgm.
Cost of grain to produce 1 kgm. gain	₱0.2756	₱0.2684	₱0.2568	₱0.2708	₱0.2603	₱0.3317	₱0.3539

[a] 5th pig died September 23, 1927.

PUBLISHED CONTRIBUTIONS OF THE COLLEGE OF AGRICULTURE: VII[1]

B. M. GONZALEZ
Dean, College of Agriculture

It has become customary to present in the last number of each volume of THE PHILIPPINE AGRICULTURIST a summary list of the scientific papers and papers of a general nature published during the year by the staff of the College of Agriculture. Owing to inadvertence we failed to print this list in the March number of the last volume. Its contents remain the same however, that is, it is for the academic year 1929-1930. The list for the present academic year will be published in the last number of the current volume for 1930-1931.

The steady output of the College in original work is now accepted as a matter of fact, and wherever discussion centers on the paucity of research in Philippine institutions, instant exception is made of the College of Agriculture even by people not connected with the institution. This ready informal recognition of the work of the College is a very valuable compensation for efforts put forth by the faculty, and deservedly so.

The conquest of nature can only be accomplished by delving into its mysteries. Rehashing of facts already discovered into more popular language is a very valuable method of disseminating knowledge and bringing it into daily use. We welcome the practice, and, furthermore, we extend our invitation to all to use the recorded products of our researches. We have observed of late, however, the unfortunate tendency, which occurs with annoying frequency, of newspapers and government entities utilizing our data and expressed ideas and neglecting the usual courtesy of acknowledging their source, thus unwittingly let us hope, passing these as their original work. This is, of course, a relatively small matter; but then again we have to consider that even scientists are human and are occasionally tempted to pause and wonder if there is not such a thing as a code of ethics governing property rights on elusive things, such as knowledge.

II. EXPERIMENT STATION CONTRIBUTIONS

The contributions are numbered serially as reported. For Nos. 1–199, *see* THE PHILIPPINE AGRICULTURIST XII, No. 7, 1923. For Nos. 200–287, *see* THE PHILIPPINE AGRICULTURIST XIII, No. 10, March, 1925. For Nos. 288–354, *see* THE PHILIPPINE AGRICULTURIST XIV, No. 10, March, 1926. For Nos. 355–440, *see* THE PHILIPPINE AGRICULTURIST XV, No.

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[1] General contribution from the College of Agriculture No. 269.

10, March 1927. For Nos. 441–517, *see* THE PHILIPPINE AGRICULTURIST XVI, No. 10, March, 1928. For Nos. 518–595, *see* THE PHILIPPINE AGRICULTURIST XVII, No. 10, March, 1929.

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(597) GORDON, ALEXANDER. 1929. Surveying for area with a surveyor's staff. The Philippine Agriculturist **18**: 201–205. *Fig. 1–8.* (Circular No. 18.)

(598) LAVA, V. G., AND F. G. ISAAC. 1929. Determination of ash of some Philippine raw sugars by the electrical conductivity method. Sugar News **10**: 186–189.

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(609) DE LA CRUZ, MARCOS M. 1929. A study of the efficiency of different materials for bagging tobacco flowers. The Philippine Agriculturist **18**: 139–181. *Fig. 1–15.*

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No. 17—Fronda, F. M., and P. S. Paje. 1929. The College trapnest. (*See* Experiment Station No. 608.)

No. 18—Gordon, Alexander. 1929. Surveying for area with a surveyor's staff. (*See* Experiment Station No. 597.)

ABSTRACT[1]

Visual selection of seed corn as related to seedling vigor and production. Numeriano A. Florita. (*Thesis presented for graduation, 1927, from the College of Agriculture, No. 312; Experiment Station contribution, No. 654*).—The objects of this work were: (*a*) to find the relation between the luster of corn seeds to seedling vigor and to the production of corn; and (*b*) to find out the influence of any visual character of the corn on vigor of seedlings.

The author used Native Yellow Flint and Moro, in this study. Ears were selected from each variety and separated according to luster of seeds, indentations of seeds, germs of seeds, size of seeds, and the number of rows to the ear. The seeds were planted in petroleum boxes containing fine sand. After a week the percentage of germination, the general stand of the seedlings, and the weight of the seedlings were noted.

The relation of the different lusters of the corn seed to production was studied in the field. Seeds of Native Yellow Flint and Moro were divided according to luster and planted in the field. Two plantings were made, rainy and dry season plantings. Three seeds were planted in each hill 75 centimeters apart in rows one meter apart. After a week the plants in each hill were thinned to two and weeded and cultivated when necessary.

At maturity the height of the plants was taken. The plants were cut at the base, dried in the sun, and the weight of the stalk and ear or ears of each plant was taken separately.

There was no significant difference in the weight of the seedlings from bright and medium–lustered seeds.

Plants grown from bright seeds produced taller plants, with heavier straw and gave a greater production of ears than the plants grown from either medium-lustered or dull seeds.

"The depth of indentation of the kernel, the size of the seed germs and the kernel itself, and the numbers of rows per ear did not show any relation to percentage of germination and to seedling vigor as expressed in weight."

—*Abstract by Rafael B. Rotor.*

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[1] Abstract prepared as part of required work in English 6, College of Agriculture.

Students at the University of California last year earned a total of more than a million dollars while taking their course. Seventy-five per cent, five thousand, of the students are partially or totally self-supporting.

—*What the Colleges are Doing.*

EXCHANGE NOTES

The Hawaiian Pineapple Co., Ltd., which is the largest of the Pineapple Companies in Honolulu, became interested in the proposition of growing and canning pineapples in Fiji for the British market. The demand in the American market is growing rapidly, and notwithstanding that the output from Hawaii is in the neighborhood of nine million cases per annum, with an export value of about seven million sterling, the demand in the United States is fully equal to the supply.

Canned pineapples are exported from Singapore, Queensland and South Africa, but it is generally admitted that in none of these countries is the product equal in quality to the standard product of Hawaii.

A delegation from the Hawaiian Pineapple Co., Ltd., visited Fiji in November, 1928, and as a result of this visit took an option over certain lands which were under the control of the Government, and had been available for lease for some years. The total area over which this option extends is about 60,000 acres. The Company has been given a license to occupy the land for a period of three years for experimental purposes, paying a nominal rental. If the experiments prove successful and the Hawaiian Pineapple Co., Ltd., decides to extend its operations to Fiji, a British company will be formed in Fiji to carry on these operations, and long term leases will be granted, of which the rental will increase as the land is brought under cultivation. . . .

If this industry is finally established on a sound commercial basis the advantages to Fiji will be very great. This Colony relies almost entirely upon two tropical products—sugar and copra. In 1928 the value of sugar exported was 67.63 per cent., and the value of copra 11.46 per cent. of the total exports. Both these industries are somewhat under a cloud at present owing to very low prices in the World's markets, so that the inception of a new industry will come at a very opportune time. In addition, there is the fact that land which is unsuitable for sugar may be excellently adapted for pineapples, which thrive best on well-drained slopes where the soil is of fair quality.

—*Tropical Life.*

Artificial lights in the laying house help greatly in regulating egg production throughout the year: they may be used to carry pullets through the period of fall molt, to start breeders laying for early hatching eggs, and to maintain hen production in the fall from August 15th on to November.

—*American Poultry Journal* (Illinois).

During the last seventeen years, in order to encourage those concerned to take the necessary steps to protect their property from damage by rats, it was the practice of the Government to purchase all rat tails brought in to appointed centers, and during this period a total of 2,449,868 tails were purchased at a cost of 17,396 pounds sterling (almost ₱173,960). . . .

It is apparent from these figures that, in spite of this large purchase of tails, there has been no actual diminution in the existing number of rats; on the contrary it appears that they are even increasing in numbers

If rats are allowed to breed uncontrolled, they are able to increase in number with remarkable rapidity, as they breed all the year round, producing an average of about eight young in each litter. Young rats are able to breed when they are three to four months old, while litters may, under suitable conditions, be produced as often as every four weeks.

A conservative estimate of the number of possible offspring of one pair of rats in a year is 880, while, making very ample allowance for casualties, it has been calculated, by another authority, that it is possible for the rat population to double its numbers in a year. . . .

From the study of the local conditions and the results obtained hitherto, it is apparent that the number of rats at present in Cyprus is very great and is on the increase, but they can be combated by the methods which have been mentioned (different methods of poisoning) and these methods may be expected to give entirely satisfactory results.

In a campaign such as that now being entered upon, in which considerable quantities of poisonous materials prepared in special ways will be used, it is essential that the actual work should be in the hands of selected and trained men who can be trusted to do their work correctly and carefully, and in consequence the whole campaign for 1930 is being organized by the Agricultural Department. . . .

In some other countries there are laws in force under which every householder and farmer is held responsible for the destruction of rats in his buildings and land.

—*The Cyprus Agricultural Journal.*

The General Sherman Big Tree in the Sequoia National Park, estimated to be at least 4,000 years old, is still producing an annual crop of cones from which fall millions of fertile seeds. The park rangers have nurseries which contain many young trees, the progeny of this oldest and largest living thing. The Methuselah of the forest perpetuates its kind to-day as it did when Cheops built the Great Pyramid in Egypt.

—*Science.*

Tuberculosis is a difficult disease to fight in a flock [of chickens] because the symptoms of the disease are not shown until the bird affected is in the last stages and about ready to die. Extreme thinness and lameness, sometimes accompanied by diarrhea, are the symptoms of avian tuberculosis, the kind that affects chickens. A post mortem examination shows the liver enlarged and dotted with yellowish-white abscesses; the spleen and intestines are sometimes affected the same way, too.

The best treatment is to get affected birds out of the flock, kill and burn them, and keep the house clean and disinfected. The use of tuberculin indicates the presence of tuberculosis. A single drop of tuberculin is injected into the edge of the wattle, or comb. Forty-eight hours later the fowls are examined and those which show a swelling at the point of injection are to be discarded as tuberculous. Cremation is the best method of disposition.

—*American Poultry Journal* (Illinois).

One hundred carloads of eggs are being assembled in San Francisco for shipment to Argentina; the world's record shipment.

—*California Cultivator.*

COLLEGE AND ALUMNI NOTES

Dr. G. O. Ocfemia, Head of Department of Plant Pathology, was elected president of the Los Baños Biological Club for the college year 1930–31, Dr. Zacarias de Jesus of the College of Veterinary Science was elected secretary.

"Mr. Hester has come back to the Philippines!" This is not a simple declaration of fact but a joyful exclamation that was frequently heard on the Campus in the last days of April. E. D. Hester was a personage in this College for some years. Hence the rejoicing in the announcement of his return to the country.

It was in 1919 that Mr. Hester was appointed on the College faculty. In that year the Department of Rural Economics came into existence under his guiding hand. It grew lustily under his able administration and untiring efforts. Mr. Hester thrives on work, especially organization and administration. As Registrar, a position accepted in addition to his department work, he organized the office now the Secretary's office. Some of the personnel now in this office received their first training under him.

Mr. Hester was no nominal member of the faculty. In all that pertained to the growth of the College he was actively interested. If an emergency called for a twenty-hour-day service from him, he put in the twenty hours.

In 1925 Mr. Hester resigned and returned to the United States and entered the service of the Department of Commerce. For the last four years he has been Commercial Attaché in Spain, first at Madrid then at Barcelona, and now he comes back to the Philippines as Trade Commissioner. The years have not lessened his loyalty to our College, where he will always find a cordial welcome.

At the fifty-second and last monthly scientific meeting for the College year of the Los Baños Biological Club, the following papers were read:

"A bacterial stem rot of hybrid cane seedling," by Mr. Emiliano F. Roldan.

"Bacteriological analysis of the water supply of Los Baños Colleges with special reference to its potability," by Dr. Zacarias de Jesus.

Dr. F. O. Santos, the retiring president, addressed the Club on "Thirty years of Filipino studies on the nutrition of man, 1900–1930."

The Department of Agricultural Education has conducted classes for three semesters and one summer school. During this time a total of 111 individual college students have been enrolled; 80 of these students have completed two or more courses each. The total enrollment by courses was 327, or about three courses per student average. A complete revision of the courses and requirements has been made to comply with new rulings by the Director of Education as to the type of training desired for each teacher graduated.

Because of inadequate equipment the enrollment in the U. P. Rural High School has been even more strictly limited this year. One entire section has been removed from the First Year program and only those students who meet the scholarship requirements are permitted to enroll in the Second and Third Years.

Miss Elvie B. Fraser, B. Ped., has been appointed as Assistant Professor of Agricultural Education. Miss Fraser came to the Philippines originally as a teacher in the Bureau of Education and was more recently a member of the College of Education faculty. She will teach English in the U. P. R. H. S.

LOYALTY

A man who is loyal to a wrong idea, however much he may approve of himself, does not thereby commend himself as a good member of society. The world at large prefers that such a man be not loyal to his own ideas. In fact, the whole force of the social machine is brought to bear on such a man to force him to be disloyal to his own notions and loyal to those of the mass.

Just so the basic Cartesian broadcast, "I think, therefore I am," should have its objective test before we build too high a social structure on its base. A rogue may prove identity by the most mischievous of cogitations, but he is still a rogue, and other folks prefer that a rogue should not think,—should have no identity. To give social value to Descartes' invention it should be supplemented by the Biblical formula, "As a man thinketh. . . so is he." If a man thinks only that which is mistaken and persists in identifying himself thereby and therewith, the man himself becomes largely a mistake, to be corrected or erased. So by direct inference we supplement Descartes' "I think, therefore I am" by the corollary "But if I am to continue to think I must first learn to think right, that is, to think constructively, not destructively." Wrong thinking is destructive not only of the power to think but of the right to exist. Why otherwise does society hang its murderers and banish its revolutionists?. . .

Now the word "loyalty" is probably one of the most-abused words in all college lingo. Any word or any idea that can endure the abuses of the campus and survive deserves to survive. True college loyalty is a very beautiful thing, one of the treasured gems of American college tradition. It is not a tag-day slogan, and it degrades the word to make it such. College loyalty has built greater memorials than monumental stadiums or gigantic alumni funds. It has built honor and fidelity and sacrifice and straight thinking in the minds of men. It has built reverence for the better side of life. It has consecrated wealth to high uses. It has perpetuated the tradition that life itself is worth living, work itself is worth doing, the tradition that good and not gold is the great objective of American life.

That "loyalty" which is gauged by vociferousness at the big game, by good fellowship at reunion banquets, by braggadocio about the superiority of any one college, is not loyalty at all. It is just animal spirits and nervous reaction and spring relaxation, or what you may please. It is just letting go and letting loose,—and who objects? We certainly do not, but it is a mighty skimpy idea of loyalty. . .

"Loyalty" as a slogan is overcapitalized, overworked. Loyalty as a virtue needs no official listing to make it valid, for loyalty is an attribute of the spirit of man which colors all his thinking and clarifies all his doing. Loyalty was the dominating motive of Lincoln, his support in every crisis, his guide in every doubt. His creed, given above in characteristic simplicity, ennobled both the virtue and the man. His was the ideal of loyalty that the college should proclaim. It barters its birthright when it substitutes therefore an allegiance which can be validated by a treasurer's receipt or certified by a tag-day posy. . . .

* * *

The words "college loyalty" are in common use. Sometimes they are associated exclusively with the cheering at a football game or the boisterous celebration of a group of graduates. They have a far deeper significance than that. College loyalty means an appreciation by a college man or woman of his or her responsibility to education which can be discharged through an effort to promote the welfare of the college of his or her choice. It is a great responsibility. A college is the highest exponent of civilization; a college is dedicated to the conservation of truth, the promulgation of truth, the discovery of truth. It is your obligation to make your college the constant objective of solicitude to the end that through your individual effort in some measure your college may better achieve its high mission. You are not too young to accept that obligation today, you will never be so old you may lay it aside.—*President Cousens, Tufts College.*

* * *

Now the whole matter hinges on the definition of college loyalty. Some people like to yell and engage in an outward demonstration of their feelings, while others abhor such demonstrations. College spirit can be just as strong without a demonstration with the vocal chords as with it. Cheer leaders need to quit making themselves ridiculous with fantastic appeals about doing one's part by giving nine "Rah-rahs." Let him that wants to yell go ahead and do it, but also let him that prefers to be loyal in some other way have peace from the scolding of cheer leaders.—*Semi-Weekly Campus, Dallas.*

—*What the Colleges Are Doing.*

If we analyse the ordinary doings of the ordinary man throughout the twenty-four hours, we find that all the objects with which he deals and most of the food he eats have come at some time or other within the province of chemical industry.—SIR ALFRED MOND.

BIOLOGICAL NOTES ON ADULT LEUCOPHOLIS IRRORATA CHEVROLAT, WITH A CONSIDERATION OF BEETLE COLLECTING CAMPAIGNS AS A METHOD OF CONTROL AGAINST WHITE GRUBS[1]

LEOPOLDO B. UICHANCO
Of the Department of Entomology

WITH THREE CHARTS

So far as can be ascertained, making a collection of *Leucopholis* beetles (*salagubang*, Tagalog; *labug-labug*, Visayan) with the object of controlling white grubs (*ulalo*, Tagalog; *bucan*, Visayan) was first practiced as a community enterprise in the Philippines in 1926, when the Bureau of Agriculture organized a campaign for this purpose in twelve municipalities of Batangas Province, Luzon. Collectors were paid at the rate of fifty centavos for a kerosene can full of beetles. (Otanes, 1927.) The campaign was considered a success, thanks to the coöperation of the energetic governor of the province, Hon. Modesto Castillo, who took a very active part. According to Governor Castillo (Castillo, 1927), the number of beetles collected in two years and the amount spent for the collecting were as follows:

Year	Number of beetles (estimated)	Cost of campaign
		pesos
1926	5,714,045	952.00
1927	1,680,000	280.00

Following the lead of Batangas, and encouraged by the results claimed, the province of Negros Occidental adopted a similar practice. In the campaigns in this province, however, a large part of the funds used in payment for the beetles caught was furnished by the sugar centrals and planters' associations. The writer has been informed that La Carlota Central alone, together with its planters' association, appropriated for the project in the La Carlota District for 1930 the sum of ₱10,000.

The principle involved in this method of combat against the pest sounds plausible enough. In the words of Otanes (1927):

> There were collected in the whole twelve municipalities [of Batangas in 1926] more than 2,000 petroleum canfuls of beetles or, as calculated, more than 10,000,000 individuals. Allowing that the sexes were in equal proportion—that is to say that one-half of these, or 5,000,000, were females and that each female on the average would have laid about twenty eggs—which is a low estimate—they would have laid in round numbers 100,000,000 eggs. Imagine how many grubs these would have meant, and how many hectares of cane these grubs would have infested and damaged!

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[1] Experiment Station contribution No. 656. Received for publication May 14, 1930.

These are purely conjectural arguments, however. There has been no attempt to determine by carefully checked observations whether or not the expense and effort involved in this method is justified by the results obtained in practice. Indeed, the mere scarcity or absence in injurious numbers of white grubs in the years following a campaign cannot, without good evidence, be justly attributed to the effects of beetle collection. It is a well known fact that there are many natural environmental agencies at work which normally influence periodical fluctuations in the numbers of destructive insect pests.

It must be pointed out at this juncture that the present critical analysis of the results of beetle collecting as a measure against white grubs is made without losing sight of the fact that even if, as a hypothetical case, all the individuals caught were females, the method would still remain of doubtful value. In *Leucopholis irrorata*, we are dealing with a species which in the adult stage can subsist on the leaves of at least forty different species of cultivated or common wild trees and an undetermined number of other host plants in forests and waste lands. It is, therefore, manifestly impossible with the most energetically conducted campaigns to destroy more than an insignificant percentage of the beetle population in a given locality. Hence, this procedure, with all its seductive appeal to popular fancy, evidently produces little or no impression on white-grub infestation. Of course, the method would have been positively efficacious if campaigns had been undertaken at a time when the sole representatives of *Leucopholis irrorata* were the Adam and Eve of the species. But unfortunately, this insect, as judged by its phylogenetic relationships, must have come into being during the Miocene or the Oligocene period, probably eons before the earliest human ancestors of the present ardent advocates of beetle-collecting campaigns existed.

OBJECTS OF THE PRESENT WORK

(1) To determine in samples taken at random from beetles collected in campaigns the relative numbers of males, gravid females, and spent or sterile females. (2) To ascertain by dissection the reproductive potentiality of the females caught. (3) To gain such information on biological characteristics of the adults as may be deduced from statistical treatment.

TIME AND PLACE; ACKNOWLEDGMENTS

The main portion of the work was carried on as a part of a general investigation on sugar cane insects in Negros Occidental in March, April, and May, 1930. Thanks are due to Mr. H. Atherton Lee, director of the research bureau of the Philippine Sugar Association, for his efforts in arranging for the writer's trip to Negros Occidental and to the trustees of the Association for having so liberally voted funds for use in the present work. Generous coöperation was also given by Mr. A. W. Lopez, entomologist of the Association.

Data from field and laboratory work which the writer has been carrying on in Luzon during the past two years have been added wherever they were deemed useful in explaining certain points in the discussion.

MATERIALS AND METHODS

At the beginning of the work in Negros there was only one place where beetles were caught in abundance—in and around Hacienda Pilar, Hawaiian-Philippine District, where intensive campaigning had been going on since the beginning of March. A few beetles were beginning to fly in some of the haciendas near La Carlota, but they were not sufficiently numerous then to warrant any campaign. Samples were secured from both places; from Hacienda Pilar, about 10,000 beetles, and from Hacienda Adelina, La Carlota, through the courtesy of Mr. Grage, only 59. The Hacienda Pilar lot consisted of beetles caught on March 27, 1930, from the trees in the neighborhood, in the following manner: Mango, talisay (*Terminalia catappa* L.), sinigüelas (*Spondias purpurea* L.), banana, and other trees were shaken or jarred briskly, causing the beetles clinging thereon to fall to the ground; they were then gathered. Collection was also made among the sugar cane on the leaves of which the adults frequently feed. These beetles were turned in daily to the deputy governor, who resided at Hacienda Pilar, and the collectors paid at the rate of ten centavos a hundred. The writer was informed that price was the prevailing rate in Negros. A small lot from Hacienda Adelina was collected on March 28.

Subsequently, Mr. S. M. Cendaña, instructor in entomology at this College, who was temporarily in the employ of the Association during the summer of 1930, made counts, at the writer's request, in the La Carlota District, at Hacienda Esperanza on April 12 and at Hacienda Pacita on May 2. According to Mr. Cendaña, beetles began to fly in appreciable numbers at Hacienda Esperanza on April 9 and at Hacienda Pacita on April 28.

The lots secured were examined with the least possible delay. Care was taken to study the beetles on the same day they were caught in order to minimize errors in random sampling consequent upon any possible differences in rate of mortality between males and females and also any chance of later development of ovarian contents which might tend to disturb results. A part of the lot from Hacienda Pilar was kept alive on banana leaves in a cage without soil and another series of examinations made four days later, to determine whether or not any change subsequently took place in the female reproductive potentialities.

A description of the method of examination may be of interest to other workers. When the lot was large, random samples were taken of the beetles from different parts of the containing bag. These samples were placed together in a separate container and every individual included therein examined. Inasmuch as the adults exhibited no externally visible secondary sexual characters, the sexes could be determined only by eversion of the genitalia. The beetle examined was previously paralyzed by pressing the thoracic region between the tergum and the sternum. Then the female genital plates or the male aedeagus was exposed by a gentle manipulation with the thumb and forefinger along the abdomen. In some apparently abnormal male specimens wherein the gonaphyses could not be made to protrude, the sex was judged both by dissection and by the highly eversible, thickwalled ejaculatory duct. In the female, the vagina, which is homologous to the latter male organ, is thinner walled and collapses upon application of strong pressure on the abdomen. Females were invariably dissected and the number of eggs present in each individual counted.

PRESENTATION OF RESULTS AND DISCUSSION

Species of beetles caught. All the beetles in the lots examined belonged to one species, *Leucopholis irrorata.* Larvae of this species are usually the most destructive white grubs of sugar cane and of other crops in Luzon, Negros, and other parts of the Philippines.

Proportion of males, gravid females, and spent or sterile females. The detailed results of the lot from Hawaiian-Philippine are presented in table 1. These are summarized in table 1a and in chart 1, wherein it will be

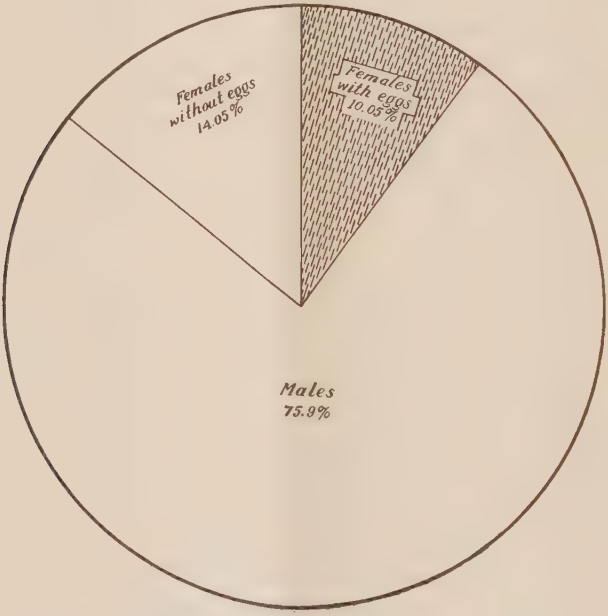

Chart 1.—Proportion of males, gravid females, and spent or sterile females in sample from Hacienda Pilar, Hawaiian-Philippine, collected March 27, 1930. Based on table 1a.

seen that only a small proportion, 10.05 per cent, of the beetles caught in the campaign in that locality consisted of reproductive females. The rest was made up by males, 75.9 per cent, and females without eggs, 14.05 per cent, or a total of 89.95 per cent of beetles the destruction of which would not contribute to the diminution of the source of future grubs. That the eggless females in the lot were either spent or sterile and not merely immature is shown by the closeness of values in the parallel columns in table 4, wherein a comparison is made of the females dissected on the date of collection and four days later. A detailed report on the latter observation is given in table 2.

The figures given for Hacienda Esperanza (table 6) of 78.73 per cent males and for Hacienda Pacita (table 7) of 69 per cent males somewhat approximate the values for this sex for the Hawaiian-Philippine lot. It is worthy of note, however, that the proportion of gravid females, which is 21.23 per cent at Esperanza and 23 per cent at Pacita, is over twice as much. The explanation is, apparently, that while in those two haciendas the census was taken three and five days after appearance of large broods, the Hawaiian-Philippine lot was not considered until after over a month had elapsed. Consequently, at Esperanza and Pacita it would be reasonable to expect a greater preponderance of young females that had not yet become spent.

Likewise, on the basis of table 8, the following preliminary deductions are deemed justifiable:

1. The percentage of males was highest within three days after the initial occurrence of the heavy brood of the year because the beetles were still very young and many of the females at that time were under the surface of the ground and ovipositing. This condition is attested by the fact that there was then only a very small percentage, 0.04, of spent females, as against 21.23 per cent gravid, in the beetle population collected in the open.

2. The proportion of males was lowest five days after the initial occurrence of the large brood because the female components of the population in the open were augmented by the females that had become spent and gone out again from under the surface of the soil. Moreover, the increase in the proportion from 0.04 per cent to 8 per cent is indicative of the rapidity of oviposition in gravid females, a considerable number of which became spent within five days from the time of their mating flight.

3. The proportion of males rose again after over one month from initial occurrence of large brood to only 2.83 per cent less than the young three-day lot from Hacienda Esperanza, because by this time the beetles composing the population in the open had become old and reënforcement through subsequent emergence of younger broods practically negligible. Hence, the ratio of fresh, gravid females was very small, 10.05 per cent; the rest was made up by spent females that returned to the open after their oviposition activities in the ground were concluded. That the ratio of the spent females fell far below that of the males, which were now presumably

largely spent also, is apparently an indication that the former, on account of the greater drain on their system in producing and laying eggs, do not survive long their period of fecundity.

It will, of course, be highly desirable to supplement these observations with a series of regularly followed up statistical surveys of *Leucopholis* adults in single localities and with direct biological observations on beetles of known ages under controlled conditions in the laboratory.

Males and production of young. The normal method of reproduction in *Leucopholis irrorata*, as well as in other members of the order Coleoptera to which it belongs, is by amphigony. In this species, no case of parthenogenesis has as yet been observed. Mating apparently takes place entirely in the open, after dusk, when the beetles actively take to flying. The writer was able to observe only partially the duration of copulation, for as long a period as two hours; but presumably the process takes a very much longer time, since in the morning, when the adults are inactively clinging to leaves of trees, some of the pairs are still found in copula. During the process, the individuals are so firmly joined that when they are separated forcibly, the male genitalia usually become torn.

In view of the rôle of the males in reproduction, would not destruction of a large number of adults of this sex and the consequent reduction of the chances of mating by the females be a beneficial result of beetle-collecting campaigns? In answering this question, it should be borne in mind that the females were mostly spent or sterile. In gravid females, most of the individuals contained much smaller numbers of eggs than the maximum of 28 found in dissection (chart 3).[2] Likewise, in a large majority of the females the spermatheca was found distended owing to its being filled with spermatozoa, as confirmed by microscopic examination of the contents of that organ. From these indications, therefore, most of the males had already outlived their usefulness in so far as mating is concerned. The females had already been fertilized and many had laid eggs. It must be remembered that female insects, as a rule, need to be served by the males only once or at most a few times during their lifetime, since spermatozoa can be stored indefinitely in the spermatheca where they are held in readiness for fertilization of the eggs which pass out into the vagina.

Moreover, campaigns as usually conducted, result in collecting only from trees in the neighborhood which are readily accessible. Hence, whatever males are killed can easily be replaced by immigration from other places. That *Leucopholis* beetles can fly for quite a distance may be inferred from the fact that in the town of Calamba, in Laguna Province, during the months of May and June, children collect them from trees in orchards in fair quantities. The nearest place where grubs of this species are known to occur in that vicinity is at Patay na Ilog, which is a barrio of Cabuyao situated about five kilometers from Calamba.

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[2] Mr. Cendaña found one female out of a lot of 268 individuals at Hacienda Esperanza in La Carlota District which contained a maximum number of eggs of 32.

Another matter which should be taken into consideration in this connection is the fact that the adults do not all emerge in one day, even in the favorable months when the largest broods of the year occur. The fact that the grubs found in fields where symptoms of infestation are prominently discernible are almost all in the second, but more often in the third instar, is not an indication that these individuals are coetaneous, for both instars take months to complete. Our laboratory records on the life history of *Leucopholis irrorata* give the following intervals:

Second instar....................	56 to 98 days
Third instar.....................	166 to 172 days

It is thus practically certain that the male population is continuously reënforced by new adults emerging from their pupal cases in the ground.

An interpretation of the low numerical ratio of females caught. In unisexual animals, the typical sex ratio is fifty-fifty, that is, one-half of the number in the population of a given species should consist of males and the other half females. In *Leucopholis irrorata* there are no disturbing factors, like occurrence of heterogony, polymorphism as in social insects, etc., which would tend to modify the typical ratio, so that the numbers of the sexes in that species should be alike. The relatively small number of females at Hacienda Pilar, Hawaiian-Philippine District (tables 1 and 1a, and chart 1) and at Haciendas Esperanza (table 6) and Pacita (table 7), La Carlota, may be interpreted as due to the fact that the females soon after mating go under the ground in order to oviposit. The presence of a large proportion of spent, if not sterile, females can only mean that they generally go out of the ground after their egg-laying process is completed and spend the rest of their lives in the open. Corroborative of this point is the fact that, in our work in Luzon, as well as in Negros, dead adults have seldom been dug out of the ground, even in spots where initial infestation of the field occurs and where presumably the females had gone under and laid their eggs. On the other hand, at Patay na Ilog, Cabuyao, Laguna, there are two sinigüelas trees under which we have, since 1928, repeatedly observed piles of dead *Leucopholis* adults after the occurrence of heavy broods in May and June.

The males probably do not return under the ground after they have gone out following emergence from the pupal stage. Consequently, a by far larger proportion of this sex is caught from the trees.

The Hacienda Adelina lot (tables 3 and 3a and chart 2) has a possible significance in that it represents adults collected before the appearance of large broods in that district and when the *Leucopholis* adult population was as yet composed of a few straggling individuals. Although the entire lot, consisting of only 59 beetles, was considered, there was inherently a greater chance for error in sampling. In dealing with so small a number, a

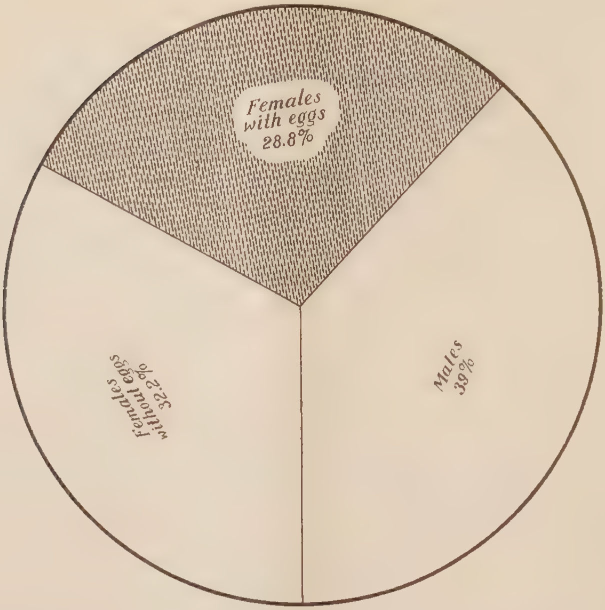

Chart 2.—Proportion of males, gravid females, and spent or sterile females in sample from Hacienda Adelina, La Carlota, collected March 28, 1930. Based on table 3a.

difference of one or two individuals would naturally have considerable effect on the calculation of percentages. In this lot the number of females present was 61.02 per cent of the total, or 22 per cent more than that of the males. But again, the number of gravid females in the lot was only 28.8 per cent of the total, or 10.2 per cent less than that of the males. If these findings were representative of the conditions then prevailing in Hacienda Adelina, they were probably due to the fact that young adults were still so few and the intervals between emergence of broods so long that most of the old males had been eliminated through natural death or by being devoured by birds or other predators before new ones appeared. Females, on the other hand, remained sheltered in the soil while ovipositing and thus had less chance of meeting a violent end. Hence, the coexistence of old spent females with young egg-bearing adults and with, probably, mostly young males.

As a further evidence that the preponderance of females in the lot from Hacienda Adelina is a consequence of uncompensated depletion of the number of adult males in the population, and not the expression of an intrinsically characteristic sex-ratio, the percentages therein of spent or sterile and of the gravid with the total number of females closely approximate those of Hacienda Pilar (table 5).

Egg production in Leucopholis. The closeness of the figures in the two columns of table 4 wherein are compared the records of two examinations at an interval of four days indicates that in the adult stage after the beetle issues out of the ground no new eggs are developed. As reported in table 1, nine of the females dissected contained small, undeveloped eggs. On the other hand, in the dissections made four days later (table 2) all the eggs were fully developed, with completely formed chorion. It may be inferred from these findings that, in this species, the potential number of eggs is extruded into the ovaries before the adult escapes into the open. Subsequently the only development that takes place in the ovarian contents is increase in size and maturation of the ova which are already there. The presence of a copulating pair (table 1, specimens Nos. 474 and 475) in which the female contained no egg does not prove that she is young and that eggs had not yet begun to be extruded, since mating is a process which is quite independent of egg production.

The average number of eggs to a female recorded in tables 1, 3, and 7 range from 3.11 to 5.2. The upper limit represents females from Hacienda Pacita, La Carlota, in which the census was taken five days after initial appearance of large broods, while the lower limit is that of the small, straggling brood from Adelina. Likewise, upon plotting the data on percentages of egg-content frequencies of females (chart 3) in Hacienda Pilar (over one month after initial appearance of large broods) together with Pacita (five days after initial appearance of large broods) and Esperanza (three days after initial appearance of large broods), certain significant points suggest themselves. Due allowance should, of course, be made for environmental differences in the three localities which may tend to disturb uniformity of results. The following tentative deductions are made from the data available so far:

1. Individual females apparently exhibit inherently wide variations in egg-contents. The greatest number of eggs obtained from one individual was 32. Whether or not this number represents the maximum limit in egg-producing capacity of female *Leucopholis* may be ascertained only by dissection of a large number of known freshly emerged females—a very difficult undertaking owing to the fact that it is not easy to induce last-instar larvae to pupate in the laboratory and pupation of this species in nature occurs at as deep as 1.2 meters below the surface of the ground.

2. The fact that the greatest number of eggs was found in only from 0.8 to 1.75 per cent of individuals in each of the three lots would seem to indicate either a low initial egg-producing capacity of the females or a rapid rate of oviposition among gravid females. That the latter condition is probably the more correct is shown by the almost progressive rise in the frequency curves with the lessening in egg-content.

3. The sudden rise of the frequency curves in the groups which contained no eggs in the three lots is a further indication of the rapid rate of

oviposition, resulting in the females being spent quickly. The numerical progressive gradation of frequencies at Hacienda Esperanza (3 days after initial large brood), Pacita (5 days after), and Pilar (over a month after) also tends to substantiate this point.

4. Among the gravid females in the three lots, not only is the discrepancy in egg-contents manifest in the average but also in the frequency of females with respect to egg-contents. It is unfortunate that the data for average egg-contents for Hacienda Esperanza are not available; but the difference between 5.2 eggs of Hacienda Pacita and 4.14 of Pilar, correlated with the percentage curves of egg-content frequencies, shows a progressive mass diminution in reproductive capacity within a month from the occurrence of the initial large brood. This fact tends to show that after the occurrence of the first heavy brood of the year in a given locality, the number of adults which emerges subsequently is too small to compensate for mortality in the older stock. While there is a fair number of individuals which contain from 11 to 26 eggs, especially in the five-day lot from Hacienda Esperanza, the highest frequency occurs in 3 to 10 egg-groups.

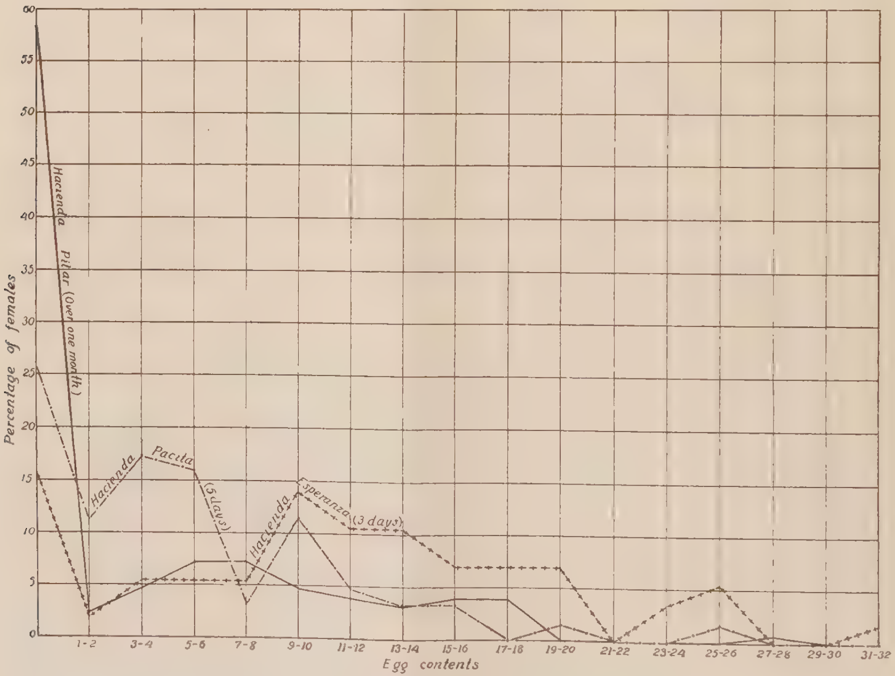

Chart 3.—Frequency percentages of *Leucopholis* females classified according to egg contents.

Economic considerations. The females in the Hawaiian-Philippine lot recorded in table 1 contained a total of 526 eggs. At the prevailing price for beetles of 10 centavos a hundred in Negros, the lot consisting of 526 beetles, would cost ₱0.53. Since these beetles are collected and paid for as a means of preventing the laying of eggs which would give rise to grubs, the eggs would cost at that rate ten for one centavo. At the same rate, the lot from Hacienda Pacita, in which there was a total of 322 eggs in the 200 beetles, the eggs would cost sixteen for one centavo. It would be assuming too much to consider all these eggs as future grubs. Any one who has worked with the life history of this species is familiar with the difficulty in raising grubs from the eggs, since the highest percentage of mortality occurs in the egg stage and in the first larval instar. Ants and certain species of mites decimate them in spite of the best of care.

Moreover, the course of the eggs from the ovaries to their final destination in the ground is beset with uncertainties, for any of the innumerable accidents which might befall the mother during the intervening time or failure of the mother at critical moments to locate herself in suitable soil owing to prevalent unfavorable weather conditions or other untoward factors would prevent oviposition.

General discussion. Destruction of adult insects in order to minimize production of young and in this way prevent future heavy infestation in a given locality is an old practice in economic entomology. However, although the method has been found to work in some conspicuous cases, it obviously cannot be of application to all pest species. A general, sweeping recommendation as to collecting and killing the adults of *Leucopholis irrorata* would be warranted if supported by adequate proofs in regard to efficacy. The adults themselves are not real pests of any cultivated plant. They eat very sparingly and the damage they cause is almost negligible. In addition to the objections pointed out in the introductory part of the present paper, another matter which is frequently overlooked is that the egg and earlier larval instars are confined to certain very special types of soils into which the female beetles find their way and oviposit. Thus, with the relatively limited oviposition sites available, there would always be beetles competing to lay eggs in habitually infested fields so long as many of them remain at large.

All things considered, the writer is of the opinion that gathering adult *Leucopholis* as a community enterprise has very little merit, if any, to commend it. The more logical procedure, it seems, is the more direct one of concentrating efforts of control on the grubs themselves in habitually infested areas. The following methods have suggested themselves during the course of our work: (1) Prevention of oviposition by the female in soils that serve as ideal oviposition sites. The actual factors which determine suitability of certain spots in a given field for egg laying is still a subject for conjecture; but there appears to be a persistent correlation with soil pockets, or depressions, into which considerable organic material is periodically deposited by flood during the rainy season. It may be possible to obviate the formation of these infestation foci through artificially diverting flood water by a system of drainage canals, or by rendering such spots unavailable to the ovipositing beetles by application of certain protective substance, as coal tar kerosene emulsion. We have found this reagent to act both as an insecticide and repellant and to remain effective in the soil for as long a period as two months. (2) In cases of infestation, corralling the grubs by means of a shallow trench saturated with that emulsion as soon as the initial symptoms of their presence are detected. The object is to prevent the grubs from spreading to other parts of the field. As, at that time, the affected spots of the field are still small, the method should be neither difficult nor expensive. The process, which will be described in more detail in a separate paper, has been found to work satisfactorily in practice in the white-grub infested fields near Canlubang, in Laguna Province.

A supplementary measure which is probably more applicable than daytime collecting is to spray sinigüelas and mango trees in the vicinity of oviposition sites with stomach poisons, as lead arsenate or Paris green. In this way mating females will be reached as they issue from the ground, inasmuch as these two species of plants are among the favorite hosts. The writer found triturated green leaves in the digestive tubes upon dissection of gravid females, showing that these forms, as do other *Leucopholis* adults, feed on leaves. It may even be advisable to plant these trees for this purpose in fields that are habitually affected by *Leucopholis* grubs. Spraying should begin when signs of emerging sizable broods first commence to appear and the process repeated until the danger from the presence of many ovipositing females is past.

In this connection, attention should be called to the fact that although *Leucopholis irrorata* produces the most destructive forms of white grubs, owing to greater number and wider range of adaptability to different soil types, there are other species of allied pests which also cause considerable injury. Principal among these are species of *Holotrichia*, *Lepidiota*, *Anomala*, *Alissonotum*, and *Autoserica*. The range of each one of these and the period of the year in which each is found in most destructive numbers varies with the species and the locality. This matter is discussed in a preliminary way in a report on an entomological survey in Negros sugar cane fields, March, 1930 (Uichanco, 1930). However, the habit of the grubs of starting their infestation in certain foci in the field is apparently common to all species.

SUMMARY AND CONCLUSIONS

1. Two objections are pointed out against beetle-collecting campaigns as a method of control of grubs of *Leucopholis irrorata*, even if, as a hypothetical case, all the individuals caught were females: (*a*) The large number of species of host trees growing in places which are not readily accessible and the resulting destruction of only an insignificant percentage of adults. (*b*) The limited number of soil spots that offer favorable sites for oviposition,

into which consequently are narrowed the centers of reproductive activity of the surviving gravid females.

2. Indications at Hacienda Pilar, Hawaiian-Philippine District, and at Haciendas Esperanza and Pacita, La Carlota, are that a large proportion, 69 to over 78 per cent, of the beetles caught in campaigns are males. During the first few days following the initial appearance of large broods of adults, the remaining part is largely composed of gravid females; but their number soon becomes reduced and that of spent females correspondingly augmented.

3. Destruction of the males in a given locality through campaigns would not reduce chances of mating, inasmuch as their number can easily be reënforced by immigration from other places and by continuous emergence of new males. The distance of flight of adult *Leucopholis* is quite considerable; from evidence in Laguna Province, it has been calculated to be as far as five kilometers.

4. Adults begin to fly actively and presumably mate in the open soon after dusk. The process of mating probably lasts for a number of hours, pairs in copula having been occasionally found in the morning, when the beetles are torpidly clinging on the leaves of trees. These pairs are so firmly joined that when they are forcibly separated, parts of the genitalia are torn.

5. The beetles are not themselves real pests, because of the almost negligible damage they cause in that stage.

6. The females contained an average of from 3.11 to 5.2 eggs for each individual. The greatest number, 32, was found in only one, while the highest frequency of females was in the 3 to 10 egg-groups. Indications from the percentage curves of egg-frequency in females are that after the emergence of the first heavy brood of the year, which apparently occurs within a week in a given locality, the number of new adults which subsequently appears is too small to compensate for mortality in the older stock. Likewise, evidence points to the fact that the rate of oviposition is rapid and the female soon becomes spent. Indications are that within five days from the mating flight many of the females finish laying their quota of eggs. The females apparently do not survive long their period of fecundity but die soon after they become spent.

7. The proportion of males to females in the open was highest within three days from initial occurrence of the large brood of the year in a given locality, owing apparently to many of the females remaining under the surface of the ground in order to lay eggs; was low five days after large brood, because many of the females had then become spent and returned to the open; and high again over one month later because apparently the subsequent broods added only a meager part to the population and many of the old females had become spent and soon thereafter died.

8. The case of the small lot from Hacienda Adelina, La Carlota, in which the proportions were 39 per cent males, 32.2 spent or sterile females, and 28.8 gravid females, is explained as due to the fact that these specimens were collected too early in the season in that locality, when large broods of adults had not yet emerged from the soil. The individuals constituting the broods were so few and the intervals between broods so great that the old males had probably perished before the younger ones appeared. On the other hand, females were more safely protected under the soil during the time they were laying eggs, so that more of the old, spent individuals could continue to survive and coexist with the younger generations.

9. From the findings in the heavy broods at Haciendas Pilar, Esperanza, and Pacita, inference is made that the males do not return under the surface of the ground after they go out. On the other hand the females, after mating, re-enter the ground in order to lay eggs and usually go out again after they have become spent and continue to spend the rest of their lives in the open.

10. Two methods are suggested for white-grub control; namely, (*a*) rendering habitual oviposition sites in the field unavailable to the beetles through diverting flood water to other places by a system of canals or by application on these small areas of a suitable protective substance, as coal tar kerosene emulsion; and (*b*) watching for signs of initial infestation and preventing spread of the grubs to other parts of the field, preferably by corralling them with an emulsion-treated trench.

11. In preference to daytime collecting, spraying with stomach poisons, such as lead arsenate or Paris green, favorite hosts, as sinigüelas and mango, in the vicinity of *Leucopholis* grub infested fields would reach the mating females as they issue out of the ground and feed. The measure is, of course, at best merely supplementary. Recommendation is made that these host trees be planted to be used as poisoned bait in affected areas. Spraying should be started as soon as the first broods of beetles begin to appear and be repeated at reasonably frequent intervals until the danger is past.

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TABLE 1

Adults of Leucopholis irrorata collected at Hacienda Pilar, Hawaiian-Philippine, March 27, 1930. Census taken on the same date

BEETLE NO.	SEX	NUMBER EGGS	BEETLE NO.	SEX	NUMBER EGGS	BEETLE NO.	SEX	NUMBER EGGS
1	♂		35	♀	8	69	♂	
2	♂		36	♂		70	♂	
3	♂		37	♂		71	♀	0
4	♀	18	38	♂		72	♂	
5	♂		39	♂		73	♂	
6	♂		40	♀	0	74	♂	
7	♂		41	♂		75	♂	
8	♂		42	♂		76	♂	
9	♂		43	♂		77	♂	
10	♂		44	♂		78	♂	
11	♀	0	45	♂		79	♂	
12	♂		46	♂		80	♂	
13	♂		47	♂		81	♀	8
14	♂		48	♂				(small)
15	♂		49	♂		82	♀	0
16	♂		50	♂		83	♀	0
17	♂		51	♂		84	♂	
18	♂		52	♂		85	♂	
19	♂		53	♂		86	♂	
20	♂		54	♂		87	♂	
21	♂		55	♂		88	♂	
22	♂		56	♂		89	♂	
23	♀	8	57	♂		90	♂	
24	♂		58	♂		91	♂	
25	♀	0	59	♂		92	♂	
26	♀	10	60	♂		93	♀	14
27	♂		61	♂		94	♂	
28	♂		62	♂		95	♂	
29	♂		63	♂		96	♂	
30	♂		64	♂		97	♂	
31	♂		65	♂		98	♂	
32	♀	0	66	♂		99	♂	
33	♂		67	♂		100	♂	
34	♂		68	♂		101	♀	4

TABLE 1—(*Continued*)

Adults of Leucopholis irrorata collected at Hacienda Pilar, Hawaiian-Philippine, March 27, 1930. Census taken on the same date

BEETLE NO.	SEX	NUMBER EGGS	BEETLE NO.	SEX	NUMBER EGGS	BEETLE NO.	SEX	NUMBER EGGS
102	♂		143	♂		184	♂	
103	♂		144	♂		185	♀	0
104	♂		145	♂		186	♀	10
105	♂		146	♂		187	♀	4
106	♂		147	♀	0	188	♀	14
107	♀	0	148	♂		189	♂	
108	♀	0	149	♂		190	♂	
109	♂		150	♂		191	♂	
110	♂		151	♂		192	♀	16
111	♂		152	♂		193	♀	0
112	♂		153	♂		194	♂	
113	♀	0	154	♂		195	♂	
114	♂		155	♂		196	♂	
115	♂		156	♀	10	197	♂	
116	♂		157	♂		198	♂	
117	♂		158	♂		199	♂	
118	♂		159	♂		200	♀	10
119	♂		160	♂		201	♂	
120	♂		161	♂		202	♂	
121	♂		162	♂		203	♀	0
122	♂		163	♂		204	♀	6
123	♂		164	♀	0			(small)
124	♂		165	♂		205	♂	
125	♂		166	♂		206	♂	
126	♂		167	♂		207	♂	
127	♂		168	♂		208	♂	
128	♂		169	♀	0	209	♂	
129	♂		170	♂		210	♀	0
130	♂		171	♂		211	♂	
131	♂		172	♂		212	♂	
132	♂		173	♀	0	213	♀	4
133	♂		174	♂				(small)
134	♂		175	♂		214	♂	
135	♂		176	♂		215	♂	
136	♂		177	♂		216	♂	
137	♀	0	178	♂		217	♂	
138	♂		179	♂		218	♂	
139	♂		180	♂		219	♂	
140	♂		181	♂		220	♀	0
141	♂		182	♀	12	221	♂	
142	♂		183	♂		222	♂	

TABLE 1—(*Continued*)

Adults of Leucopholis irrorata collected at Hacienda Pilar, Hawaiian-Philippine, March 27, 1930. Census taken on the same date

BEETLE NO.	SEX	NUMBER EGGS	BEETLE NO.	SEX	NUMBER EGGS	BEETLE NO.	SEX	NUMBER EGGS
223	♂		261	♂		299	♂	
224	♂		262	♀	8	300	♂	
225	♂				(small)	301	♂	
226	♂		263	♀	0	302	♀	18
227	♂		264	♂		303	♂	
228	♂		265	♂		304	♂	
229	♂		266	♂		305	♂	
230	♂		267	♂		309	♂	
231	♂		268	♂		310	♀	6 (small)
232	♂		269	♂		311	♂	
233	♂		270	♀	0	312	♀	8
234	♀	0	271	♀	6	313	♂	
235	♂		272	♂		314	♀	0
236	♂		273	♀	0	315	♂	
237	♂		274	♂		316	♂	
238	♂		275	♂		317	♂	
239	♂		276	♀	0	318	♂	
240	♂		277	♂		319	♀	0
241	♂		278	♂		320	♀	14
242	♂		279	♂		321	♂	
243	♀	0	280	♂		322	♂	
244	♂		281	♂		323	♂	
245	♀	0	282	♂		324	♂	
246	♀	4	283	♀	0	325	♂	
		(abnormal)	284	♂		326	♀	0
247	♂		285	♀	0	327	♂	
248	♀	0	286	♀	12	328	♂	
249	♂		287	♀	8	329	♂	
250	♂		288	♀	2	330	♂	
251	♂		289	♂		331	♂	
252	♂		290	♂		332	♂	
253	♂		291	♀	0	333	♂	
254	♂		292	♀	0	334	♀	8
255	♂		293	♀	0	335	♂	
256	♂		294	♂		336	♂	
257	♀	0	295	♂		337	♂	
258	♀	18	296	♂		338	♂	
259	♂		297	♂		339	♂	
260	♂		298	♂		340	♀	12

TABLE 1—(*Continued*)

Adults of Leucopholis irrorata collected at Hacienda Pilar, Hawaiian-Philippine, March 27, 1930. Census taken on the same date

BEETLE NO.	SEX	NUMBER EGGS	BEETLE NO.	SEX	NUMBER EGGS	BEETLE NO.	SEX	NUMBER EGGS
341	♂		381	♂		420	♀	6
342	♂		382	♂		421	♂	
343	♂		383	♂		422	♀	0
344	♀	0	384	♂		423	♀	0
345	♂		385	♂		424	♂	
346	♂		386	♂		425	♂	
347	♂		387	♂		426	♂	
348	♂		388	♂		427	♀	8
349	♂		389	♀	0	428	♂	
350	♂		390	♀	18	429	♂	
351	♀	0	391	♀	0	430	♂	
352	♂		392	♀	0	431	♂	
353	♂		393	♂		432	♂	
354	♂		394	♂		433	♂	
355	♂		395	♂		434	♀	0
356	♂		396	♂		435	♂	
357	♂		397	♂		436	♂	
358	♂		398	♂		437	♂	
359	♂		399	♂		438	♀	10
360	♂		400	♂		439	♀	0
361	♂		401	♀	0	440	♂	
362	♂		402	♂		441	♂	
363	♀	14	403	♂		442	♀	0
364	♂		404	♀	28	443	♂	
365	♂		405	♂		444	♂	
366	♂		406	♂		445	♂	
367	♂		407	♂		446	♀	6
368	♂		408	♂		447	♀	0
369	♂		409	♀	6 (small)	448	♀	2 (small)
370	♀	10				449	♀	2 (small)
371	♀	18	410	♂		450	♂	
372	♀	0	411	♂		451	♂	
373	♂		412	♂		452	♂	
374	♀	0	413	♂		453	♂	
375	♂		414	♂		454	♂	
376	♀	16	415	♂		455	♀	12
377	♂		416	♂		456	♂	
378	♂		417	♀	16	457	♂	
379	♂		418	♂		458	♀	0
384	♂		419	♂		459	♂	

TABLE 1—(*Continued*)

Adults of Leucopholis irrorata collected at Hacienda Pilar, Hawaiian-Philippines, March 27, 1930. Census taken on the same date

BEETLE NO.	SEX	NUMBER EGGS	BEETLE NO.	SEX	NUMBER EGGS
460	♀	6	495	♀	6
461	♂		496	♂	
462	♀	0	497	♂	
463	♂		498	♀	0
464	♂		499	♂	
465	♂		500	♂	
466	♀	0	501	♂	
467	♂		502	♀	0
468	♂		503	♂	
469	♂		504	♀	0
470	♂		505	♀	0
471	♀	0	506	♂	
472	♀	0	507	♂	
473	♀	0	508	♀	0
474	♀	0	509	♂	
475	♂	(in copula)	510	♀	0
476	♂		511	♂	
477	♀	0	512	♂	
478	♂		513	♂	
479	♀	0	514	♀	4
480	♀	0	515	♀	0
481	♀	0	516	♀	0
482	♀	4	517	♀	11
		(small)	518	♂	
483	♀	7	519	♂	
484	♀	0	520	♂	
485	♂		521	♀	6
486	♀	0	522	♀	0
487	♀	15	523	♂	
488	♂		524	♂	
489	♂		525	♂	
490	♂		526	♀	15
491	♀	0	527	♂	
492	♂				
493	♂				
494	♂				

TABLE 1a

Résumé of table 1

	TOTAL NUMBER	PROPORTION TO TOTAL
		per cent
Leucopholis adults considered	527	
Males	400	75.9
Females	(127)	(24.1)
Without eggs	74	14.05
With eggs	53	10.05
Average number of eggs per female	4.14	

TABLE 2

Egg contents of females in Leucopholis adults from the same lot as table 1, but dissected March 20, 1930

BEETLE NO.	NUMBER EGGS	BEETLE NO.	NUMBER EGGS
528	2	545	0
529	0	546	3
530	0	547	0
531	0	548	0
532	0	549	0
533	16	550	0
534	8	551	0
535	0	552	3
536	8	553	2
537	0	554	14
538	22	555	4
539	0	556	0
540	0	557	0
541	0	558	0
542	12	559	0
543	3	560	6
544	8		

TABLE 3

Adults of Leucopholis irrorata collected at Hacienda Adelina, La Carlota, March 28, 1930. Census taken the same date

BEETLE NO.	SEX	NUMBER EGGS	BEETLE NO.	SEX	NUMBER EGGS
1	♀	0	30	♀	0
2	♀	0	31	♀	0
3	♂		32	♂	
4	♂		33	♀	0
5	♀	6	34	♂	
6	♂		35	♀	0
7	♀	10	36	♂	
8	♀	0	37	♀	0
9	♀	8	38	♀	0
10	♂		39	♂	
11	♀	0	40	♀	1
12	♀	0	41	♀	7
13	♂		42	♂	
14	♀	6	43	♂	
15	♀	0	44	♀	0
16	♂		45	♀	10
17	♀	0	46	♀	0
18	♀	7	47	♀	8
		(small)	48	♂	
19	♀	0	49	♀	12
20	♂		50	♂	
21	♀	0	51	♂	
22	♀	0	52	♀	2
23	♂		53	♀	3
24	♀	0	54	♂	
25	♀	4	55	♂	
		(small)	56	♀	4
26	♀	10	57	♂	
27	♂		58	♀	6
28	♂		59	♂	
29	♀	8			

TABLE 3a

Résumé of table 3

	TOTAL NUMBER	PROPORTION TO TOTAL
		per cent
Leucopholis adults considered	59 [a]	
Males	23	39.00
Females	(36)	(61.02)
Without eggs	19	32.2
With eggs	17	28.8
Average number of eggs per female	3.11	

[a] The small number is due to scarcity of adults at time of survey. The number represents entire lot available.

TABLE 4

Comparative rates of reproductive and non-reproductive females of tables 1 and 2, (Hacienda Pilar lot, dissected on date of collection and four days later)

	MARCH 27, 1930	MARCH 30, 1930
Total number of females considered	127.00	33.00
Percentage with eggs	41.73	42.42
Percentage without eggs	58.27	57.58
Average number of eggs per female	4.14	3.42

TABLE 5

Proportion of spent or sterile and of gravid females to total number of females in Hacienda Adelina and in Hacienda Pilar. Based on tables 1 and 3

	HACIENDA ADELINA	HACIENDA PILAR
Total number females	36	127
Number spent or sterile	19	74
Number gravid	17	53
Percentage of spent or sterile	52.8	58.3
Percentage of gravid	47.2	41.7

TABLE 6

Adults of Leucopholis irrorata collected at Hacienda Esperanza, La Carlota, April 12, 1930

	NUMBER	PERCENTAGE
Total number of beetles considered	268	
Males	211	78.73
Females	57	21.27
Without eggs	9	0.04
With eggs	48	21.23

TABLE 7

Adults of Leucopholis irrorata collected at Hacienda Pacita, La Carlota, May 2, 1930

	TOTAL NUMBER	PERCENTAGE
Total number of beetles considered	200	
Males	138	69
Females	62	31
Without eggs	16	8
With eggs	46	23
Total number of eggs in the lot	322	
Average number of eggs per female	5.2	

TABLE 8

Comparative proportions of males and gravid and spent females in the population three, five, and over thirty days after initial large brood (based on tables 1a, 6, and 7)

	MALES	FEMALES		
		Total	With eggs	Without eggs
	per cent	*per cent*	*per cent*	*per cent*
Hacienda Esperanza (3 days after initial large brood)	78.73	21.27	21.23	0.04
Hacienda Pacita (5 days after)	69.00	31.00	23.00	8.00
Hacienda Pilar (over 1 month after)	75.79	24.10	10.05	14.05

OBSERVATIONS ON THE ACTIVITIES OF FOWLS IN THE LAYING HOUSE[1]

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WITH ONE CHART

Fowls are restless animals. In their natural state where there are no restrictions on their movements they are constantly moving about hunting for food. Under conditions of domestication, however, the amount of their activity is dependent more or less upon the conditions of the weather and upon the convenience of the caretaker. Probably, the many methods employed in their care and management were originally based principally upon these two fundamental considerations. Especially is this the case where poultry is raised on a commercial scale where a definite system has necessarily been followed in order to effect an economy not only of labor and of space but also of the amount of feeds given to the birds.

Undoubtedly, the problems of poultry management are more numerous and complicated and more difficult to solve in temperate countries where the weather conditions differ widely from those prevailing in the tropical regions, the part of the globe long recognized as the original home of the domestic fowl. Because of the fact that we have been accustomed to adopt temperate zone methods in nearly all of our lines of endeavor, the system of management of our live stock is based upon methods established in these zones, with of course slight variations to suit peculiarities inherent to tropical countries. Accepting the fact that temperate and tropical climes are widely different, variations in the activities of the live stock in these two regions may be expected to vary also. The question may then be asked: To what extent are we justified in our present system of live stock management?

No report of studies along this line in the Philippines is available. In Texas a study of the activities of live stock on the range was undertaken so as to obtain definite information concerning their behavior on the range and their requirements and preference in range forage (1927). The information obtained from this study is helpful in developing a system of grazing so that the vegetation of the range can be utilized to the best advantage. Cory (1927) also cited a report, in a Norwegian publication, of a study relative to the use of time made by animals in the pasture. This study, however, is more limited in its scope than the one made in Texas.

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[1] Experiment Station contribution No. 657. Received for publication May 29, 1930.

We are not aware of any report published along this line on other species of live stock and poultry. The laying habits and other associated activities of the hen have, however, been studied rather carefully. Among these studies are those of Goodale (1915), of Patterson (1916), of Turpin (1918), of Payne (1921), and of Atwood (1927). Outside of these publications, no report is available.

The present report is limited to poultry. The studies were begun in 1923, but at the end of a year, because of important reasons, the work was temporarily stopped. These early studies dealt mainly with the laying habits of the hen. In October, 1928, the work was resumed and continued for one year or till September, 1929. In this period all the major activities of the laying hen were observed carefully and the data obtained are presented in this paper. We believe that because of the fairly uniform climatic conditions in the Philippines, such studies as are reported here could not have been carried on more advantageously in another country.

PLAN OF THE WORK

The plan followed in 1923 was to observe at what part of the day most of the hens laid their eggs. Observations were made at intervals of two hours, from 6:00 o'clock in the morning to 6:00 o'clock in the evening. The observations in the later work were made at hourly intervals from 5:00 o'clock in the morning to 7:00 o'clock in the evening. Observations were made during these hours daily during the last seven days of each month from October, 1928, to September, 1929. When it was dark, as was the case early in the morning and in the evening, either a "Dietz" storm kerosene lantern or an ordinary flash light was used.

A pen consisting of 50 Cantonese pullets was used. These fowls were penned in one end of a laying house consisting of three compartments, measuring 7.3 meters by 3.67 meters or an area of 26.8 square meters each, thus allowing about 0.54 square meter of floor space to each bird. Trapnests, one nest for every 2.5 birds, were used. These were visited at hourly intervals, also. There were three rows of perches, the total length measuring 18.7 meters or 0.37 meter for each bird. A broody cage, 0.82 by 1.30 meters in size, is located on one end of the droppings board, and as soon as a hen was seen to be broody she was placed in the coop. Each broody hen remained in the broody cage at least four days.

The birds had access to two grassy lots of 12.0 × 34.0 meters in size. Except for what little shade the house and the newly transplanted young fruit trees in the yards could give, no other shade in any form was available outside the laying house.

Management. This flock was managed in the same manner as the rest of the flocks of the College. Grain which consisted of equal parts of corn and palay was given shortly before 7:00 o'clock in the morning and at about 5:00 o'clock in the afternoon. Approximately one-third of the daily ration of grain was given in the morning and the rest in the afternoon. This ration was scattered in the grassy yard behind the house, except on days when there was a heavy rain, then the grain was fed by scattering it on the floor of the house, which is of lake-shore sand with a good amount of shells, either entire or broken, mixed with it.

Dry mash which consisted of 4 parts by weight of rice bran, 3 of copra meal, 2 of corn meal and 1 of dried shrimps was fed in an open mash trough placed inside the house. The mash trough which is provided with 304 centimeters or 6.1 centimeters for each bird of feeding space along the sides was kept well supplied with mash. Clean drinking water was available all the time in one corner of the house towards one end of the dry mash feeders. The watering can which was open all the time measures 22 by 22 centimeters with a standing space around it totalling 152 centimeters.

The pen was cleaned once a week. The sand litter was replaced twice during the year the observations were made. Both the grain and mash were stored in bins which were refilled once a month. The flock was fed by the same man throughout the year, and it was the plan to give the birds one part of grain to one part of mash. To prevent errors as much as possible, in a great majority of the cases, the observations were made by the same individual.

Terms used. The "poultry day" is that approximate portion of the day (twenty-four hours) from the time the birds get down from the perches in the morning to the time when they go back to roost in the evening. The poultry day is used by the birds in a number of major activities. These activities may be described as follows:

Sitting on the perches. The birds found on perches at the different hours that the observations were made were recorded. The birds may have been sleeping or only resting.

Laying. The number of birds laying was determined by the number found inside the trapnests. As soon as a bird showed signs of broodiness, it was placed in the broody cage. The number of birds in the broody cage was recorded at each hour of observation.

Scratching. The number of birds observed to be scratching both inside the house and outside were recorded. At first it was rather difficult to observe this activity as the birds would suddenly stop scratching when the observer approached the pen. Later, however, the birds paid no attention to the observer but kept on scratching.

Idling. This word expresses the activity of layers, some on their feet, but apparently not engaged in any other major activity and some lying on the ground dusting themselves. The hens that were on their feet were either walking around or standing still. When observed outside the house, the majority were in the shade, others were walking around but apparently with no definite object.

Drinking. Drinking refers to the number of birds seen on the drinking stand at the different hours of the day. This number was carefully observed and recorded.

Feeding. This term refers to the feeding of the birds on the mash stand. Thus the number of birds found on the mash stand at the hours of observation was recorded.

All these observations were reported in terms of percentage of the entire flock. To determine this, the number of birds observed in each of these different activities during the hours of observation was made were added together and the total was compared with the total number of birds observed in the pen during the same period. The totals for the seven-day observation were used for this purpose. Thus an average was reached

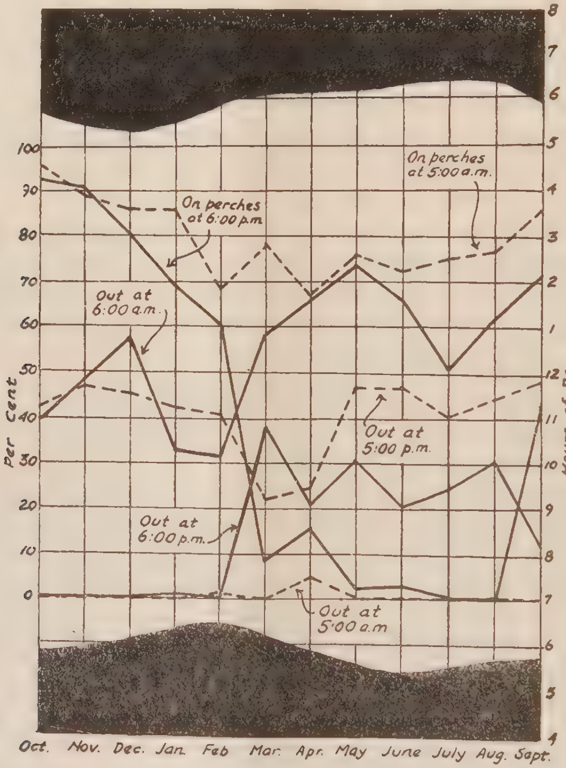

Chart 1.—Showing the percentage of the entire flock seen both outside and inside the house morning and evening during the different months of the year. Those that were seen on the perches at 5:00 o'clock a. m. and at 6.00 o'clock p. m. are also given. The hours of sunrise (lower) and of sunset (upper) for the different months of the year are shown in the shaded portions.

which greatly minimized errors that would have crept in had the actual numbers observed been used. The difficulty of getting the actual figures for each activity is recognized. It would have been impossible to follow each of the fifty birds used in the study throughout the entire day. The data here presented, however, may be considered as representing a tendency with a fairly reasonable degree of certainty.

RESULTS

The poultry day. While effort was made to record the complete poultry day, it was impossible to watch each one of the fifty birds used in this study and follow each bird from the time it got down from the perch in the morning to the time it returned to roost at night. However, the hour when the birds left the roost was approximately determined during the different months of the year, and the time when they returned was also observed. The data are given in table 1, and graphically presented in chart 1.

It may be observed in this table that the majority of the birds left the perches some time between 5:00 o'clock and 6:00 o'clock in the morning. During the time from September to February, most of the birds went to roost at 6:00 o'clock in the evening, and from September to December, a few individuals were observed sitting on the perches as early as 5:00 o'clock in the afternoon. From March to June, the majority of the birds were stil busy on the ground as late as 6:00 o'clock in the evening, while in July and August, no bird was observed on the roosts at this hour. It was a rare occurrence to find a bird on the perches at other hours of the day.

These figures suggest a very close relationship between the rising of the sun and the time the bird gets down from the roost and the setting of the sun and the bird's roosting time. Roughly speaking, the earlier the sun rises, the earlier the bird gets down from the roost, and, similarly, the later the sun sets, the later the hen goes to roost in the evening. During one-half of the year, the number of hours of daylight is more than twelve as shown in table 1 and chart 1. From October to January, the day is less than twelve hours. Apparently, the chicken follows the daylight, getting down from the perches as soon as it is bright enough for it to seek food and not going back to roost so long as it is light enough to see to walk around although in either case the bird may not be able to eat. There was a number of instances when a few chickens were seen going around inside the house early in the morning, even when it was still quite dark.

Incidentally, in this connection, the number of birds found outside the house may serve as a clue to their different activities. Although the details are not given, the figures in table 2 show that, irrespective of weather conditions some of the birds go outside of the house. It was observed that when it rained the tendency of the birds was to stay under cover at least the first hour or so, and then go out in spite of the rain. It also may be seen from table 2 that although the birds would tolerate rain, as soon as it became hot, they would go inside the house. This was especially noticeable during the hottest months of the year. From February up to July, the number of birds seen outside the house from 9:00 o'clock in the morning was not so large as during the other months. This suggests the necessity of providing sufficient shade in the yards, especially when it is taken into consideration that the chicken is an outdoor loving animal.

It is apparent that there is no marked relationship between the percentage of egg production of the flock and the percentage of the flock outside the house either at 6:00 o'clock in the morning or at 5:00 o'clock in the afternoon. (See table 6.) While it was to be expected that the greater the percentage of the birds laying the greater the percentage to be seen outside the house during these two hours, there are factors that may modify this expectation, for instance, the amount of food available to the birds at the time and the weather conditions. To be more specific, the length of daylight may be considered as one of the most important factors that may influence the going out and in of the birds. Chart 1 shows this tendency very markedly. The earlier the sun rises, the greater the percentage of birds seen outside the house at 6:00 o'clock in the morning. A similar tendency is shown in the relationship between the time the sun sets and the percentage of birds seen outside the house at 5:00 o'clock in the evening.

Feeding. In the recording of data only mash feeding was taken into consideration, for the reason that the flock was hand-fed with grain at definite stated hours of the day. It may be noted in table 3 that, except during October and November, there is no hour of the day from 6:00 o'clock in the morning to 6:00 o'clock in the evening when there was no bird on the mash stand. During February, April, May, and June, a few birds were seen on the mash stand as early as 5:00 o'clock in the morning, but during these same months, with March included, when the weather was exceptionally good, a number of the birds would rather go outside of the house at this hour than stay on the mash troughs. On rainy or even cloudy mornings, most of the birds instead of going out as soon as it was light would stay on the mash stand for some time. From October to January may be cited in this regard. In most instances, however, there was a general tendency for the birds to stay around the mash stand from 9:00 o'clock to 11:00 o'clock in the morning, and from 3:00 o'clock in the afternoon till the roosting hour. A number of birds was seen on the mash stand even as late as 6:00 o'clock in the evening, which in a way shows that they would eat mash as long as there was enough light for them to see what they are eating. These observations would suggest that in order to allow the birds sufficient opportunity to eat all they want of the mash, the mash hoppers should be opened as early as possible in the morning and should be kept open in the evening until the birds have gone to roost. If it were not for losses that may be incurred through rats stealing the mash feed, it would be the right procedure to keep the mash troughs open all the time, so as to avoid the necessity of going to the poultry house very early in the morning just to open them. These observations indicate the wisdom of keeping the mash troughs open and accessible to the birds at all hours during the day so as to enable the birds to go to them any time they so desire.

Drinking. It is also of interest to note that the distribution of the number of birds seen on the water stand at each hour of the day was fairly uniform, as shown in table 4. There was, however, no time when the water stand was full to its capacity. It was surprising to see birds drinking as early as 6:00 o'clock in the morning. Apparently, the condition of the weather had little influence on the number of birds to be seen on the water stand during the hours observations were made. No check was made on the amount of water consumed by the birds during the different months of the year.

This distribution of the birds seen on the water stand at each hour of the day may be expected. In the first place, the nature of the mash feed given to the birds is such that it is likely the individuals will want to drink soon after eating it. Hence, a slight relationship may be observed between the number of birds seen on the water stand and those seen on the stand during the different hours observations were made. This seems to point out the necessity of having a supply of water close to the mash trough, so that the birds can go to it at any time. It is essential that the drinking vessels be kept filled with water from early morning until evening.

Laying. The results obtained in a previous study (data unpublished) that the majority of eggs are laid in the morning were confirmed in this investigation. (See table 5.) Quite a number of nests began to be occupied as early as 6:00 o'clock in the morning and nests were still occupied as late as 6:00 o'clock in the evening. However the birds that were found in the nests early in the evening, 7:00 o'clock, were released, although they showed early signs of broodiness. If these birds persisted in staying in the nest up to 7:00 o'clock the following morning, without any sign of an egg in the oviduct, they were placed in the broody coop. Undoubtedly, a few of the birds found in the nest at 6:00 o'clock in the morning belonged to this group, but the fact that quite a number of eggs were collected the following hour, 7:00 o'clock, shows that not all of those seen in the nests at 6:00 o'clock were broody. From 8:00 up to about 12:00 o'clock at noon, the number of birds seen inside the trapnests was about the same. From 1:00 o'clock in the afternoon the number of birds seen in the nests gradually decreased. A very small number of birds laid between 4:00 and 6:00 o'clock in the afternoon.

It is also interesting to note that the maximum percentage of the flock that was found in the nests in one single hour of observation was 26.2; this occurred at 12:00 o'clock in February. It may be seen also that during the same month records of 25.3 per cent of the entire flock were observed at

9:00 and also at 11:00 o'clock. From February to July it appears that in order to have a sufficient number of trapnests for a flock of layers, there should be at least one nest for every four birds so as to avoid overcrowding. Even if this number is provided, the laying house should be visited at hourly intervals, otherwise, the laying of a number of the birds will be delayed. If the laying house cannot be visited at hourly intervals, three birds for each trapnest available may be considered sufficient.

It was observed also that the birds preferred to lay in the same place; it was not an uncommon experience to find two or three birds waiting for the same nest. Although no exact figures are available regarding the exact length of time a bird spent inside a nest when laying, it was observed that a hen seen inside a nest at a certain hour will invariably have laid by the next hour observation was made. To make accurate observations on this particular habit of layers, it would be necessary that open nests and not trapnests be used. The following observations by Turpin (1918) may be quoted in this connection:

> Considerable variation was found in the length of time hens spend on the nest in laying. The average was found to be 1 hour and 35 minutes for each of two tests made with White Leghorns, 1 hour and 45 minutes, and 1 hour and 49 minutes respectively in two tests with R. I. Reds and 2 hours and 16 minutes in one test with a flock of White Plymouth Rocks. When the total time spent by the hens on nests when not laying was added to the total time spent when laying, an average of about 2 hours for each egg produced was found in each case.

It is also interesting to note that the distribution of egg production observed in this study is in general essentially the same as that reported by Fronda in 1928. The only differences that may be noted are the heights of the curves for the different periods, the 1928-1929 flocks having a much higher percentage of egg production than that reported in 1928. This may be expected for the reason that the figures reported in 1928 represent an average for five years, 1922-1927, of a flock which consisted of both Cantonese pullets and hens in almost equal numbers, whereas the present figures are on Cantonese pullets only.

While on this point, it may be seen from table 6 that the number of broody hens observed during the different months of the year varied considerably. The average percentage of broodiness for the month was determined by adding the average percentage of the flock that was confined in the broody cage at each hour of observation and then dividing the total by the number of hours during which observations were made. As may be seen in table 6 there seems to be a strong relationship between the percentage of egg production and the percentage of broodiness, as the higher the percentage of egg production, the higher the broodiness. Thus the percentage of broodiness was higher during the months of fairly heavy production, December to August, than during September to November. However, the period when the highest percentage of egg production was recorded did not occur at the time when the highest percentage of broodiness was observed. This was to be expected. After laying a batch of eggs, the hens invariably would become broody, and if this broodiness was broken immediately as was the case in this study, they would be only a few days inside the broody coop. Then a short period of rest followed, and a corresponding drop in egg production would be recorded. The general tendency of the curves of percentage broodiness and percentage of egg production, however, is the same.

Idling. Table 7 gives the number of birds observed inside the house that apparently were not engaged in any apparent major activity. Table 8 gives those birds under the same classification but outside the house.

It may be seen from table 7 that while the birds would leave their roosts early in the morning, they would walk around with no definite object other than probably waiting for the daylight to become brighter. Similarly, they would linger quite late in the evening before going to roost. It may be mentioned in this connection that the number of birds that apparently were idling inside the house is dependent upon the weather conditions. Quite a number of them were ofttimes engaged in dusting themselves. As has been stated elsewhere, on a rainy day the chickens would stay inside the house the first few hours and after resting for some time quite a number would go out in spite of the rain. A larger number of birds, however, were observed idling inside the house during the hotter parts of the day than during the other hours.

Comparatively speaking, a smaller percentage of the birds were seen idling outside the house than inside. These figures show also that a small percentage of the birds would stay idle outside the house during the hot part of the day. Most of those that were observed outside during these hours when the heat was greatest were seen under the scanty shade that the house and the young fruit trees provided. This again points out the necessity of shade in the yards.

A few more birds were observed walking around the yards early in the morning and late in the afternoon than during the other hours of the day (see table 9). It was also observed, although the table does not show it, that the birds would walk around the yard in the rain but not on the sunny days. From March to June or July, an almost negligible number of birds would walk around the yard from 8:00 o'clock in the morning to about 3:00 o'clock in the afternoon. During the other months of the year, when it was not so hot, the distribution of birds walking around was practically uniform. It was also observed that most of the birds walking outside in the early morning hours as well as in the late afternoon preferred the grassy portions of the yards. That the birds would stay outside walking around with apparently no definite object until the later hours of the afternoon, or so long as it was light enough for them to see is also shown in table 9. Thus the length of time the birds spent outside the house, as has been pointed out elsewhere in this paper, is apparently dependent upon the length of the day.

As expected, a considerably larger number of birds were observed to be busily engaged scratching in the yards from 6:00 to 7:00 o'clock in the morning than at any other hour of the day (see table 10). The birds are hungry in the morning and the first impulse, of course, is to go out and look for food to break their fast. Since grain was fed shortly before 7:00 o'clock in the morning, the birds were still busy looking for left-overs when observation was made at this hour. Still a few of them were seen scratching at 8:00 o'clock. From then on, the birds would be seen scratching almost anywhere inside the yard. Most of those observed were noted to be still looking for stray kernels in the place where the afternoon grain was scattered. Except in a number of instances, 1:00 o'clock in February, 11:00, 12:00, 1:00 and 3:00 o'clock in March, 11:00 and 12:00 in April and 10:00 o'clock in August, the percentage of the flock observed to be scratching during the other hours of the day was practically the same. In spite of the fact that there was food available inside the house the whole day, a fair number of birds could be seen scratching outside the house. Whether they were scratching seeking for additional food materials to supplement the food supplied them or for exercise cannot be stated definitely. It may be mentioned here that there is sufficient grit and shell materials on the floor of the house, so that looking for these outside would seem to be unnecessary.

SUMMARY AND CONCLUSIONS

1. The results of a year's observations regarding the major activities of a flock of fifty laying Cantonese pullets are reported in this paper.

2. It was observed that the majority of the birds left the perches some time between 5:00 and 6:00 o'clock in the morning.

3. From September to February, most of the birds went to roost at about 6:00 o'clock in the evening; during the other months, they started to go to roost as early as 5:00 o'clock.

4. The length of the "poultry day" was observed to be closely related with the length of daylight.

5. More birds were observed to go outside the house on rainy days than on the hot days.

6. There is apparently no marked relationship between the percentage of egg production of the flock and the percentage of the flock outside the house, either at 6:00 o'clock in the morning or at 5:00 o'clock in the evening.

7. Except in a few instances, there was no hour of the day from 6:00 o'clock in the morning to 6:00 o'clock in the evening when there was no bird on the mash stand.

8. There was a more general tendency for the birds to stay around the mash stand from 9:00 to 11:00 o'clock in the morning and from 3:00 o'clock in the afternoon to roosting time than at other hours of the day.

9. The distribution of the number of birds seen on the water stand at each hour of the day was fairly uniform, although there was no time when the water stand was crowded to its capacity.

10. It was observed that the most eggs were laid in the morning, from 7:00 to 12:00 o'clock.

11. Under the conditions of the experiment, one nest for every four birds was necessary to avoid over-crowding.

12. It was observed that the percentage of broody hens was higher during the months of fairly heavy production than during months when egg production was comparatively low.

13. A larger number of birds was observed idling inside the house during the hotter parts of the day than during the other hours.

14. It was observed that more birds were walking around the yard early in the morning and late in the afternoon than during the other hours of the day.

15. The study revealed real need for shade in the yards.

16. In spite of the fact that a supply of food was always available to the birds, a fair percentage of the flock was seen scratching outside the house at all times of the day.

17. Except in a few isolated instances, no bird was observed resting on the perch during the day between the time when it had left the perch in the morning to the time when it went to roost for the night.

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TABLE 1

Birds seen sitting on the perches at each hour of the day during the different months of the year, expressed in percentage of entire flock

TIME OF DAY	MONTHS											
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
5[a]	95.7	89.0	85.7	86.0	68.5	77.8	66.6	75.6	72.3	74.5	76.9	86.1
6	3.7	0.0	0.0	27.0	7.8	7.8	0.9	0.0	0.0	0.0	0.0	0.2
7	0.0	0.0	0.3	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	1.5	0.0	0.6	0.0
9	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	1.2	0.6	0.0	0.0
10	0.3	0.0	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.9	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.3	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.8
5	10.6	2.3	8.9	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	1.2
6	92.5	90.6	80.1	68.2	60.1	8.3	15.5	2.1	2.7	0.0	0.0	42.6
7	94.2	91.2	83.6	82.5	74.4	80.6	75.6	81.8	75.9	77.8	76.7	90.3
Sunrise	5:46	5:52	6:6	6:21	6:25	6:13	5:52	5:34	5:26	5:30	5:39	5:44
Sunset	5:46	5:28	5:24	5:38	5:55	6:4	6:8	6:13	6:22	6:29	6:26	6:8
Hours of daylight	12′ 0″	11′ 36″	11′ 18″	11′ 17″	11′ 30″	11′ 51″	12′ 16″	12′ 39″	12′ 56″	12′ 59″	12′ 47″	12′ 24″

[a] Add "broodies" (table 6) to these figures.

TABLE 2

Birds outside the house at each hour of the day during the different months of the year, expressed in percentage of entire flock

TIME OF DAY	MONTHS											
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
5	0.0	0.0	0.0	0.0	1.5	0.0	4.5	0.0	0.0	0.0	0.3	0.0
6	39.9	48.2	57.4	32.7	31.2	58.0	65.5	73.2	66.0	50.2	61.4	70.7
7	43.5	64.1	55.7	46.4	45.0	55.2	30.3	52.4	40.2	34.4	56.0	60.0
8	39.3	45.0	40.5	51.5	39.0	49.0	25.3	29.2	23.2	17.0	46.5	47.7
9	21.7	38.0	42.0	38.4	25.0	20.2	12.5	11.6	11.1	16.1	28.3	41.8
10	12.0	38.3	51.5	31.0	21.5	25.4	16.9	18.2	18.9	16.4	16.3	35.3
11	25.6	51.4	37.5	28.7	28.6	21.2	9.0	21.7	11.9	15.2	11.5	36.3
12	26.4	34.8	45.3	45.2	24.7	11.4	4.7	11.6	13.7	9.6	15.6	44.1
1	31.0	36.9	51.7	41.3	19.7	2.8	1.5	12.5	4.2	19.5	23.3	49.0
2	38.5	39.5	63.2	42.8	22.6	17.3	2.1	24.4	18.5	14.9	16.5	55.0
3	56.9	52.3	57.2	40.8	26.8	8.3	20.8	36.0	29.2	21.0	31.6	48.6
4	23.3	40.3	57.2	38.6	24.7	25.3	14.0	45.2	34.8	26.1	29.8	38.7
5	42.8	46.8	45.5	42.2	40.8	22.2	24.4	47.0	46.7	40.1	44.5	48.2
6	0.0	0.0	0.0	0.6	0.0	37.8	20.2	30.7	20.2	24.0	30.2	12.2
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 3

Birds seen on the mash stand at each hour of the day during the different months of the year, expressed in percentage of entire flock

TIME OF DAY	MONTHS											
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
5	0.0	0.0	0.0	0.0	0.3	0.0	0.6	1.2	0.3	0.0	0.0	0.0
6	15.2	14.3	9.2	5.1	8.3	5.2	1.5	2.4	2.4	5.2	6.4	5.6
7	12.3	5.6	4.8	6.0	6.5	8.0	17.3	4.5	4.5	6.4	5.3	8.5
8	17.2	8.8	13.4	10.2	11.3	2.8	8.6	6.8	6.5	5.8	6.4	9.2
9	21.8	20.5	12.2	16.1	14.9	21.2	7.1	10.7	11.3	11.8	19.5	15.0
10	16.1	18.1	10.7	17.2	19.9	14.3	5.4	13.7	8.0	11.5	13.1	14.3
11	18.1	11.4	11.3	22.3	11.6	6.2	5.1	9.2	6.9	7.9	11.8	14.3
12	17.5	10.4	8.3	11.9	9.2	5.9	6.3	8.9	5.7	5.0	7.1	11.4
1	12.1	12.0	8.3	16.4	13.9	9.7	5.9	8.0	5.9	10.0	5.0	10.6
2	16.4	14.9	4.8	11.3	13.7	10.8	7.4	9.2	6.2	7.9	8.3	9.2
3	13.8	14.0	4.2	13.4	12.2	10.8	4.5	8.0	7.7	13.4	9.2	13.2
4	21.8	19.9	7.4	12.2	12.2	10.4	10.4	10.4	8.3	8.9	9.5	14.4
5	19.5	20.8	12.5	11.3	9.7	13.2	7.1	6.6	7.4	6.5	10.6	13.8
6	0.0	0.0	2.8	3.6	8.3	14.9	18.8	12.8	13.2	20.1	16.2	12.3
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 4

Birds seen on the water stand at each hour of the day during the different months of the year, expressed in percentage of the entire flock

TIME OF DAY	MONTHS											
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
5	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
6	2.6	3.2	0.6	1.2	0.6	0.3	0.6	0.6	0.3	0.3	0.6	2.4
7	5.2	0.9	1.5	2.7	1.8	3.9	6.2	3.3	2.4	2.7	1.2	3.6
8	3.4	3.2	3.6	0.3	2.9	1.0	4.5	3.0	3.3	5.5	2.1	5.3
9	4.9	2.6	3.8	5.7	6.8	8.0	3.6	5.4	3.3	4.0	5.3	5.8
10	4.3	3.5	0.9	4.2	5.9	4.2	3.9	3.6	5.1	4.6	5.7	4.6
11	5.5	4.1	3.3	3.9	7.7	6.9	2.1	4.8	6.6	4.3	5.8	6.8
12	2.8	3.2	2.4	4.2	3.9	5.3	1.8	5.1	5.6	3.2	3.5	5.8
1	6.9	2.6	2.1	5.1	5.1	9.0	4.2	3.6	4.8	4.3	3.5	4.1
2	3.7	3.8	0.9	6.0	10.7	6.3	5.1	4.5	5.6	6.1	5.6	3.4
3	4.9	3.2	0.9	5.6	6.8	5.6	5.7	6.8	4.8	6.4	2.9	3.7
4	7.8	6.1	1.5	4.5	7.1	7.3	5.7	3.3	5.1	2.7	1.5	4.5
5	8.6	5.8	4.2	5.1	5.4	9.7	7.4	8.0	3.0	3.0	3.4	7.0
6	0.0	0.0	0.0	1.5	2.7	9.3	10.7	12.2	7.7	10.0	4.7	6.3
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 5

Birds seen in the nests at each hour of the day during the months of the year, expressed in percentage of the entire flock

TIME OF DAY	MONTHS											
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	8.3	7.0	9.5	2.7	2.9	4.7	6.5	1.2	0.6	3.6	4.6	1.4
7	9.2	13.1	15.1	11.6	19.7	8.0	11.3	10.1	11.0	15.8	9.4	7.3
8	18.0	16.9	16.0	18.7	20.6	18.8	20.8	18.1	20.0	21.6	14.0	14.0
9	14.9	17.0	12.8	16.9	25.3	13.5	22.6	17.3	20.4	20.7	13.5	9.9
10	18.9	13.7	15.8	19.3	22.7	22.2	19.0	14.3	12.5	20.3	19.5	17.4
11	12.1	9.0	13.7	16.7	25.3	19.4	19.6	13.4	12.7	19.7	18.3	11.6
12	12.7	12.0	15.8	13.4	26.2	19.1	17.8	9.5	12.5	20.2	13.3	9.4
1	12.1	14.9	14.0	13.1	23.2	20.8	16.4	10.7	8.3	9.1	13.6	10.7
2	4.6	12.6	8.6	8.9	13.3	10.0	9.5	11.3	3.3	7.3	10.3	6.5
3	4.3	4.1	4.5	10.1	9.2	5.9	6.0	8.6	0.6	6.7	10.9	2.5
4	5.2	3.2	2.4	3.6	6.5	5.6	5.7	6.3	3.3	5.2	3.8	2.0
5	3.5	2.0	0.6	0.0	0.6	4.9	5.9	3.0	0.9	3.6	5.5	0.0
6	1.7	0.6	0.0	0.0	0.0	0.0	0.0	1.5	0.0	3.0	6.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 6

Distribution of broodies during the different months of the year

TIME OF DAY	MONTHS											
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
5	4.3	11.0	14.3	14.0	24.1	22.4	24.1	18.4	25.6	24.6	21.6	10.2
6	4.3	7.9	14.3	14.0	24.2	16.6	24.1	18.4	25.6	24.6	19.8	10.3
7	4.3	7.6	14.6	11.6	19.3	22.6	24.1	18.4	24.1	23.7	19.7	10.9
8	4.3	7.6	15.2	11.3	19.4	22.6	24.1	18.4	21.4	20.0	19.5	11.1
9	4.3	7.3	11.9	11.3	19.4	17.3	25.0	18.4	21.4	20.4	15.3	10.9
10	4.6	4.1	11.8	13.4	19.3	17.4	25.0	19.3	24.1	21.6	15.3	10.4
11	4.6	5.3	11.8	14.3	19.3	17.4	25.0	19.3	24.1	22.2	16.1	11.6
12	4.6	5.0	12.5	14.3	19.9	17.4	25.0	19.3	24.1	22.7	18.9	9.9
1	4.6	4.7	12.2	14.9	19.9	17.4	25.0	13.1	24.1	19.4	22.1	9.9
2	3.7	4.7	12.5	14.9	22.3	17.4	25.0	13.1	24.1	19.4	18.9	7.7
3	3.7	5.6	15.1	15.2	25.6	21.5	21.4	13.1	24.1	19.4	21.5	7.9
4	3.7	5.6	16.0	17.6	25.6	17.4	21.4	16.3	24.1	19.4	24.5	8.2
5	5.5	8.8	16.1	18.4	25.6	17.3	23.3	16.4	24.1	19.4	17.8	10.6
6	5.8	8.8	16.5	19.0	25.6	19.4	24.4	16.4	24.1	20.1	13.2	10.7
7	5.8	8.8	16.4	17.5	25.6	19.4	24.4	18.2	24.1	22.2	23.3	9.7
Total	68.1	102.8	211.2	211.7	335.1	283.5	361.3	256.5	359.1	319.1	287.5	150.0
Average	4.5	6.8	14.0	14.1	22.4	18.9	24.1	17.1	24.9	21.3	19.2	10.0
Percentage egg production	31.3	32.0	36.2	37.0	42.9	37.1	40.1	41.8	38.7	39.4	34.8	28.5

TABLE 7

Birds seen idling inside the house at each hour of the day during the different months of the year, expressed in percentage of the entire flock

TIME OF DAY	MONTHS											
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
5	0.0	0.0	0.0	0.0	5.6	0.0	3.9	3.9	0.0	0.3	0.6	3.7
6	22.3	18.2	7.2	14.0	14.6	3.4	0.9	3.9	5.1	13.4	7.0	9.4
7	21.5	8.7	4.4	18.4	6.8	2.0	10.8	9.5	13.9	14.2	6.6	6.3
8	13.8	16.7	6.2	7.1	6.5	4.8	11.9	19.7	14.9	22.5	7.0	7.1
9	28.4	11.4	12.5	8.6	7.1	16.0	17.3	30.0	20.8	17.6	11.0	10.5
10	33.5	17.0	5.1	9.5	8.3	14.3	24.7	18.4	25.3	12.2	20.2	11.9
11	37.1	12.0	13.1	11.7	2.7	20.5	26.1	20.0	25.0	19.7	21.9	15.5
12	22.7	22.5	7.5	6.5	11.6	29.8	31.5	34.3	25.9	31.5	30.7	13.6
1	23.8	18.7	7.2	1.5	13.7	27.8	37.2	42.0	37.8	19.4	18.3	12.1
2	25.0	19.5	6.3	3.0	9.9	27.4	36.0	29.1	32.7	22.5	28.0	16.5
3	14.3	17.8	14.8	5.1	10.2	39.2	30.0	24.2	21.7	16.7	18.3	20.1
4	35.4	20.2	12.2	11.9	16.7	27.5	31.8	27.9	16.9	29.8	17.4	29.1
5	7.2	12.0	8.9	6.0	12.8	31.3	28.6	18.7	11.0	26.8	14.1	18.7
6	0.0	0.0	0.6	7.1	2.1	10.3	7.1	24.3	21.4	21.3	26.8	15.9
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 8

Birds seen idling outside the house at each hour of the day during the different months of the year, expressed in percentage of the entire flock

TIME OF DAY	MONTHS											
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
5	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0
6	13.2	15.2	6.8	0.0	0.0	11.8	17.0	23.2	13.7	11.0	9.1	14.5
7	13.2	19.4	10.2	2.7	4.2	22.2	12.5	20.2	12.9	13.8	27.1	26.1
8	13.2	16.1	6.0	13.7	7.7	32.3	17.8	16.1	8.9	6.3	27.0	29.0
9	5.4	15.2	4.5	17.9	7.1	12.2	7.1	2.7	4.2	3.3	17.0	22.3
10	5.0	16.3	3.3	10.4	8.6	17.7	8.6	6.9	6.5	2.1	12.0	22.5
11	18.7	31.0	7.5	15.5	15.2	16.5	8.4	5.9	2.4	4.5	4.8	28.3
12	13.8	20.5	10.5	20.9	16.1	5.9	4.7	6.8	1.5	1.4	5.3	34.4
1	25.3	21.1	13.1	23.8	9.9	2.8	0.9	6.8	1.8	4.3	4.4	36.4
2	24.7	25.7	22.3	24.1	9.8	9.0	0.0	11.3	3.6	7.0	8.2	39.5
3	22.1	18.1	17.6	20.9	8.1	7.3	7.4	15.5	7.2	9.4	8.0	26.5
4	8.9	14.9	15.2	6.8	0.6	4.9	3.0	15.4	10.7	9.7	10.9	16.9
5	23.9	24.0	5.1	2.1	0.0	2.1	4.5	11.6	10.7	16.1	24.0	19.6
6	0.0	0.0	0.0	0.0	0.0	15.3	5.3	10.7	10.1	4.3	7.7	7.3
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 9

Birds seen walking around outside the house at each hour of the day during the different months of the year, expressed in percentage of the entire flock

TIME OF DAY	MONTHS											
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
5	0.0	0.0	0.0	0.0	1.5	0.0	1.5	0.0	0.0	0.0	0.0	0.0
6	22.6	22.8	42.6	24.1	18.4	6.9	9.9	10.7	12.5	6.4	5.5	10.7
7	24.6	30.1	36.0	25.6	14.6	6.9	5.6	13.4	7.7	5.2	4.9	5.6
8	23.2	17.2	28.0	17.3	13.7	5.6	1.2	6.0	11.3	4.3	7.0	3.4
9	5.2	8.2	24.4	11.3	13.4	3.5	0.6	4.2	4.5	2.7	7.8	2.9
10	4.3	10.0	34.2	10.4	9.5	2.4	0.0	2.7	1.8	4.9	3.9	6.3
11	4.6	13.4	19.9	3.3	8.3	3.9	0.0	3.0	9.2	2.7	2.7	1.2
12	4.3	7.3	20.1	16.9	2.7	5.2	0.0	1.8	1.5	0.0	2.9	6.1
1	4.0	10.5	8.1	8.6	9.8	0.0	0.3	0.9	1.8	5.8	3.5	7.3
2	3.7	9.4	15.4	8.0	2.7	0.3	1.5	7.4	5.1	2.7	5.3	7.3
3	4.6	20.2	27.7	8.6	6.5	0.7	5.7	5.3	3.9	4.6	13.9	11.9
4	9.8	20.4	25.9	10.1	5.9	3.1	4.2	15.8	12.5	5.2	10.0	13.6
5	14.3	16.4	20.8	13.1	15.8	6.9	5.9	10.7	10.4	12.5	7.2	8.5
6	0.0	0.0	0.0	0.0	0.0	3.1	5.6	4.5	5.6	2.7	9.8	2.2
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 10

Birds seen scratching outside the house at each hour of the day during the different months of the year, expressed in percentage of the entire flock

TIME OF DAY	MONTHS											
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
5	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.3	0.0
6	4.1	10.2	8.0	8.6	12.8	36.2	33.3	39.3	39.8	32.8	46.8	44.5
7	5.7	14.6	9.2	15.4	26.2	24.0	9.2	17.6	19.6	15.2	24.0	26.1
8	2.9	11.7	6.2	15.5	15.5	8.7	5.7	7.1	2.4	6.4	10.7	12.6
9	10.6	14.6	12.5	8.9	7.5	2.1	4.5	4.7	2.1	9.5	2.8	13.5
10	3.7	12.0	13.4	7.4	3.3	4.5	8.3	8.0	0.3	8.5	0.0	5.8
11	2.3	7.0	7.1	9.9	4.5	0.0	0.0	11.9	0.3	5.9	4.0	6.3
12	7.7	7.0	12.2	5.6	5.9	0.0	0.0	3.0	10.7	7.5	7.4	3.4
1	1.7	5.3	18.7	8.9	0.0	0.0	0.3	4.8	0.6	8.8	14.2	5.1
2	10.1	3.5	19.0	10.1	8.9	6.6	0.6	5.7	8.6	5.2	2.7	6.5
3	28.8	14.0	8.9	8.3	11.3	0.0	7.4	15.2	17.5	7.0	9.4	8.5
4	2.0	5.0	14.9	21.1	14.9	15.2	6.2	14.0	9.8	9.7	17.7	8.2
5	4.3	6.4	18.7	27.0	25.0	11.8	14.0	24.7	23.8	10.6	11.6	20.1
6	0.0	0.0	0.0	0.6	0.0	18.8	4.8	15.5	4.5	17.0	8.9	2.7
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

A STUDY OF FARM OWNERSHIP IN FIVE TYPICAL FARMING. TOWNS IN PANGASINAN[1]

DOMINGO R. CABRERA

INTRODUCTION

The study of farm ownership is important, for knowledge of the different steps actually taken by persons who have acquired farms reveals the possibilities of ownership. Also the experience of farmers in the areas under survey should prove of value to those who look forward to owning farms in that region. Very often it has been charged that in many parts of the Philippine Islands, tenancy as an institution is a permanent status, that it is never nor is it meant to be a stepping stone towards ownership as in the United States and other countries. A study of the experience of farmers previous to their owning farms should throw some light on this important question. A study of farm ownership is also of great value to students of economic and social problems of the country.

The study of farm ownership in the Philippine Islands has not heretofore received any attention. Hence, no local comparisons of the results of the survey here reported are possible.

In the United States, however, there have been several surveys which deal either wholly or partially with points within the scope of the present work.

Jefferson (1922) found, in his investigation of 515 Massachusetts farms that acquisition by purchase represented the highest percentage. Inheritance was shown to be second in importance.

Spillman (1919) and Wehrwein (1926) report that inheritance has played in various sections of the United States a very important part in the transfer or acquisition of farms.

Hibbard and Peterson (1928) report that, in Wisconsin, most of the farmers gain ownership by purchase; that there is a strikingly low percentage of acquisition of farms by inheritance.

The object of this survey was to find out important facts about the ownership of farms in typical farming towns of Pangasinan. The points investigated were: how the farms were acquired, whether by purchase, inheritance, marriage or homestead; how the purchase money was acquired, whether inherited, earned or borrowed; the year the farms were acquired; experience of farmers before they acquired farms; proportion of income derived from the farms, whether there is a surplus over expenses, and whether there are savings or not; size of farms, age of farmers at acquisition, and other kindred data.

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[1] Thesis presented for graduation, 1929, with the degree of Bachelor of Agriculture from the College of Agriculture, No. 313; Experiment Station contribution, No. 658. Prepared in the Department of Rural Economics under the direction of Mr. José E. Velmonte.

The survey was conducted during December of 1927 and April and May of 1928, in the municipalities of Binalonan, Pozorrubio, San Carlos, and Urdaneta in the province of Pangasinan.

METHOD OF SURVEY

Personal investigation with the aid of questionnaires

Questionnaires prepared in the Department of Rural Economics, College of Agriculture, were used in collecting data. A personal canvass from one farm to another was made in five selected municipalities of Pangasinan, believed to be typical towns of the province. These towns are: Binalonan, Mangaldan, Pozorrubio, San Carlos and Urdaneta. Information was obtained from farmers. The writer was familiar with conditions in the municipalities studied, before beginning the survey, so it is safe to say that the data here presented are reasonably accurate. The absence of questions involving numbers give additional assurance of reasonably reliable data. Furthermore, some of the questions were framed in such a way that any gross error could be detected easily and corrected on the spot.

Data were secured from typical farmers in the five municipalities mentioned. A total of 389 farmers were studied.

Towns studied representative of the farming communities

Pangasinan has advantages for a study of this kind. According to the 1918 census, there are in Pangasinan 161,167 farms. Of this number, 125,104, or 77.6 per cent are farms cultivated by owners, and 36,063, or 22.4 per cent, are farms cultivated by tenants. The province is thickly populated, hence, the results of such a survey would be reasonably typical of settled communities of the Islands.

In the selection of these five municipalities for the survey, several points were considered. In the first place, the municipalities are not contiguous, they are in different parts of the province. They are typically agricultural sections of Pangasinan. The social and economic conditions may be regarded as representative of other municipalities in the province.

Binalonan is located in the eastern part of Pangasinan. According to the 1918 census, there are in Binalonan 3,997 farms covering an area of 3,181 hectares, or an average of 0.80 hectare to a farm. The census of 1918 gives the total population as 17,392. These figures show that there is in Binalonan a ratio of one farm to more than four persons. The town is crossed by a first class provincial road. It produces such staple crops as rice, corn, sugar cane, tobacco and some minor crops as mungo and vegetables.

Mangaldan is located at about the north central part of the province. The census of 1918 shows that there are in Mangaldan 6,199 farms covering an area of 4,473 hectares, or an average of 0.72 hectare to a farm. The total population in 1918 was 16,761 which gives a ratio of one farm to less than three persons. The town is crossed by a first class provincial road, and has railway connections with Bauang, La Union, and Manila. All the major crops as rice, sugar cane, tobacco, coconuts and corn, as well as minor crops, such as vegetables, fruits, and peanuts are produced in the municipality.

Pozorrubio is located in the north-eastern part of Pangasinan. The total number of farms in this town according to the 1918 census is 4,977 covering an area of 6,539 hectares, or an average of 1.31 hectares to a farm. The total population in 1918 was 15,391 giving a ratio of approximately one farm for every three persons. The town is crossed by the provincial road from Lingayen to the Mountain Province. The principal products are rice and a very high quality of tobacco.

San Carlos is located in the central part of the province. According to the 1918 census, there are in San Carlos 13,710 farms covering an area of 10,024 hectares, or an average of 0.73 hectare to a farm. The census of 1918 gives the total population as 35,780 representing a ratio of one farm to less than three persons. The town is accessible by a first class provincial road and a railway line. The major crops as rice, coconuts, sugar cane, corn, and tobacco are raised in the municipality.

Urdaneta is located in the east central part of the province. The census of 1918 shows that there are in Urdaneta 7,306 farms covering an area of 7,411 hectares, or an average of 1.01 hectares to a farm. Urdaneta had a population in 1918 of 24,536, giving a ratio of one farm to more than three persons. It is crossed by a first class provincial road. Its principal crops are rice, mungo, corn, and vegetables.

DISCUSSION OF THE RESULTS OF THE SURVEY

Method of acquisition of farms

Table 1 shows that a total of 389 farms were surveyed, distributed as follows: Binalonan, 72 farms; Mangaldan, 80 farms; Pozorrubio, 80 farms; San Carlos, 77 farms; and Urdaneta, 80 farms.

These farms range in size from less than one to one hundred hectares. The average size of the farms under survey in Binalonan is 2.28 hectares; Mangaldan, 4.81 hectares; Pozorrubio, 4.50 hectares; San Carlos, 12.19 hectares; and Urdaneta, 3.79 hectares.

It will be noted that the average size of the farms under survey in each town does not closely agree with the figures from the 1918 census given elsewhere. The divergence in the size of the farms may be due to two reasons. One is, that in the survey, the farms were selected so as to include some large farms so that the study of ownership may represent both large and small farms. This was deemed necessary as small farms predominate in Pangasinan. The second reason may be found in a difference of interpretation as to what constitutes a farm. In the survey, a farm is interpreted to be the total land possession of one individual farmer under his personal direction, and found within the town under survey. His farm may be made up of one or several parcels of land which may not necessarily be contiguous. The Philippine Census does not define a farm as used in its schedules. In the United States:

> A farm for Census purposes is all the land which is directly farmed by one person managing and conducting agricultural operations either by his own labor alone or with the assistance of members of his household or hired employees. The term agricultural operation is used as a general term referring to the work of growing crops, producing other agricultural products, and raising animals and fowls.

According to Davenport,

> A farm may consist of a single tract of land, or a number of separate and distinct tracts, and these several tracts may be held under different tenures, as where one tract is owned by the farmer and another tract is hired by him. Further when a landowner has one or more tenants, renters, croppers, or managers, the land operated by each is considered a farm.

The 389 farms studied were acquired by various methods, as inheritance, gift, marriage, and purchase, involving in their acquisition a total of 742 transactions. The large number of transactions show that the acquisition of a farm by a farmer usually involves him in a number of transactions.

Acquisition by inheritance. Table 1 shows that acquisition of farms by inheritance represents a total of 335 transactions which is 45.1 per cent of all transactions. This method of acquisition was found to be preponderant in the five municipalities under survey. Urdaneta has the highest percentage, 49.7; Pozorrubio, 46.8 per cent; Mangaldan, 44.3 per cent; Binalonan, 43.8 per cent; and San Carlos, 41.8 per cent, the lowest.

Acquisition of farms by inheritance is very common in well settled communities in the Philippine Islands. The laws of the Islands as well as the custom of Filipino families make common the almost equal division of property among the children of a family. This partly explains why the farms in the municipalities under survey are comparatively small.

Acquisition of farms by gift. The number of farms acquired by gift is not large. It represents only 1.2 per cent of the 742 transactions. The isolated cases are gifts of parcels of land to adopted sons.

Acquisition of farms by marriage. Table 1 further shows that 13.5 per cent of all transactions in obtaining farms were acquisition by marriage. Of the five towns under survey, there were 100 transactions in the acquisition of farms by marriage out of the total of 742 transactions. Pozorrubio has 15.1 per cent, representing the highest; Mangaldan, 14.4 per cent; San

Carlos, 13.9 per cent; Urdaneta, 11.9 per cent; and Binalonan has the lowest, representing 11.7 per cent. It is a local custom for the parents of the bride to ask the parents of the bridegroom for a dowry for the bride; and this dowry may be in the form of a parcel of land.

Acquisition by purchase. Purchase transactions, either from relatives or others, represented a total of 298 transactions, or 40.1 per cent. A large percentage of the 389 farms were acquired by a combination of two methods, inheritance and purchase. The nucleus of a farm is usually a small area of inherited land which is enlarged later by purchase. This means of acquiring farms was found to be true in all the towns under survey.

Determined by decades when farms were acquired, table 2 shows that most of the 389 farms were acquired after 1890, although a few were acquired as early as in the decade of 1870 to 1879. The highest number of farms, 110, were acquired in the decade of 1910 to 1919. Eighty of the 389 farms were acquired since 1920, or the present decade.

Inherited farms

Table 3 shows that of the 335 farmers who inherited either part of or all their farms, 313 are farmers' sons, and only 22 are not sons of farmers. Most of the sons had worked with their fathers, becoming independent of their father's business at the average age of 22. After a short period, less than a year, they came into possession of the farms inherited, at the average age of 22.1.

Acquisition of purchase money

Table 4 shows that of the 217 farmers who acquired their farms either partly or wholly by purchase, 205, or 94.5 per cent reported that they earned the purchase money by farming only, and the rest, 11 farmers, or 5 per cent, reported that they earned it in other business; only one farmer of the 217 studied secured his purchase money for his farm through gift. No loans were obtained by any of the farmers who had purchased either all or part of their farms.

Income

Data in table 5 show the sources of income of the farmers surveyed and the proportion derived from farming. It may be seen that of the 389 farmers, 279, or 71.7 per cent reported farming as their only business. The number reported as having income from other business was 110 farmers, or 28.3 per cent. Thirty-three farmers, or 8.5 per cent, reported as deriving half or more of their income from their farms, while 77 farmers, or 19.8 per cent, reported as deriving from their farms less than one-half of their income. The farmers who reported as deriving from their farm less than half of their incomes are engaged in other business, as in the dyeing industry, teaching, in municipal government employment, and in commerce.

Surplus and savings

Table 6 shows that of the 389 farmers investigated, 218, or 56 per cent, reported having a surplus, and 171, or 44 per cent, reported having no surplus. The number reporting savings was 207 farmers, or 53.2 per cent. The surprisingly low percentage of 1.8 reported as having invested a portion of their surplus in farm improvements, in all cases the portion was very small. The question on investments in improvements referred only to those made during the last five years; this partially accounts for the small number in this group. The farmers under survey were generally found to be slow in adopting modern methods of production. They use native plows and harrows, which are very durable, hence are not frequently changed.

Experience of farmers previous to farm ownership

It is important to know what experience these 389 farmers had before they acquired their farms.

The farmers under survey were classified (see table 7) into seven groups as follows:

First group. All farmers who had had no experience before becoming farm owners other than that obtained or gained in connection with their fathers' business.

Three hundred forty-nine farmers, of whom 327 are farmers' sons, reported that they had had no experience before becoming owners of farms, except what they had gained with their fathers. The farmers' sons became independent of their fathers at the average age of 21.8 years, and immediately became owners of farms. The other 22 (non-farmers' sons) left their fathers' business at the average age of 22.9 years when they became owners of farms.

Second group. Those farmers whose only experience was that of farm laborers before acquiring farms.

Six farmers, four of them farmers' sons, or 1.6 per cent, had had experience as farm laborers before owning farms. They separated from their fathers' business at the average age of 18.5 years, and came into possession of their farms at the average age of 25.8 years, after an average period of 7.3 years of experience as farm laborers The two who were not sons of farmers became independent of their fathers' business at the average age of 17.5 years, worked as farm laborers for a slightly shorter period than did the sons of farmers, and obtained their farms three years earlier than the farmers' sons with the same experience.

Third group. Those whose only experience was that of tenant farmers before becoming farm owners.

Tenant farmers constitute 3.3 per cent. They are all sons of farmers. They were tenant farmers for almost 13 years, the longest period of experience for all groups of farmers under survey. They left their fathers' business at the average age of 21 years, and came into possession of their farms at the average age of 33.5 years. This shows that tenancy as a means towards ownership is the most difficult of the methods studied.

Fourth group. Those farm owners who had been in some business other than farming.

This group constitutes 3.6 per cent of all farmers under the survey. It is composed of those owners who had no independent farm experience before becoming farm owners, having been engaged in some other kind of business. These men spent almost eight years in other business before they attained farm ownership. The men whose fathers were not farmers stayed over a year longer with their fathers than did those who were farmers, but they spent three years less in other business. This group obtained their farms at an average age of 29.3 years.

Fifth group. Those who had had experience as farm laborers and as tenant farmers before acquiring their farms.

This group constitutes .8 per cent of all farmers reporting. It includes those who had had experience both as farm laborers and as tenants before acquiring their farms. They went to work for themselves at the average age of 18.7 years and worked eight years as farm hands and tenant farmers. They attained ownership of their farms at the average age of 26.7 years.

Sixth group. Those farm owners who had worked as farm laborers for a period and then had gone into other business.

This group constitutes only .5 per cent of the whole number of farmers reporting. It is composed of those who had had experience as farm laborers and in other business. They left their fathers' business at the average age of 19 years, worked as farm laborers and later engaged in some other business, making a period averaging ten years before acquiring their farms at the average age of 29 years.

Seventh group. Those who before becoming land owners had been tenant farmers and had been engaged also in some other kind of business.

This group includes those who had had experience as tenant farmers and in some business other than farming. This group constitutes .5 per cent of all farmers reporting. These men became owners of farms at the average age of 32.5 years, having left their fathers' business at the average age of 18 years, worked as tenants for almost eight years, and then engaged in other business for an average of seven years.

Average age of farmers at acquisition of farms

Table 8 shows, by decades, the average age of the farmers when they acquired their farms. Of the 389 farm owners in the five municipalities surveyed the age at the time the farm was acquired was 22 years.

Very few farmers reported acquisition of their farms in the first two decades, 1870 to 1879 and 1880 to 1889. They were comparatively young at the time of acquisition with an average age of 20.6 years.

Table 8 shows that most of the farms were acquired during the last four decades; namely, from 1890 to 1928. During this period the average age at which farmers came into ownership of farms was just over 22 years. The average age of the 92 farmers who attained ownership during 1890 to 1899 was just over 21 years at the time of acquisition. About 23 years was the average age of the 79 farmers who came into possession of their farms between 1900 and 1909. In 1910 to 1919, the average age of farmers who attained ownership of farms was also about 23 years. In the decade 1920 to 1928, the average age of the farmers who came into possession of farms was 24 years. It may be seen from the foregoing summary of the ages of the farmers when they acquired their farms that there has been a gradual increase in the ages at ownership.

SUMMARY AND CONCLUSIONS

1. A total of 389 farms were surveyed in Pangasinan Province, distributed as follows: Binalonan, 72 farms; Mangaldan, 80 farms; Pozorrubio, 80 farms; San Carlos, 77 farms; and Urdaneta, 80 farms. It was found that farms were acquired in several ways, by inheritance, purchase, gift, and marriage. The acquisition of the farms involved a total of 742 separate transactions. Of these transactions, 45.1 per cent represents acquisition by inheritance, and 40.1 per cent acquisition by purchase from relatives or neighbors. From the data it is obvious that most of the farms were acquired by their owners by a combination of inheritance and purchase. The nucleus of a farm is usually a small area of inherited land which is enlarged later by purchase.

2. Determined by decades of acquisition, it was found that a very small proportion of the farms under survey were acquired as early as 1870 to 1879 and 1880 to 1889. Most of the farms have been acquired since 1889, the highest number being in the decade 1910 to 1919.

3. A total of 335 farmers inherited either part or all their farms. Mangaldan has the highest percentage of farms part or the whole of which was acquired by inheritance. Binalonan has the lowest.

4. Of the 335 farmers who inherited their farms, either part or all, it was found that their average age when they left their fathers' homes was 22 years. They came almost immediately into possession of their farms. Most of these men are sons of farmers, who had worked with their fathers.

5. It was found that 94.5 per cent of the 217 farmers who acquired farms either all or in part by purchase, earned the purchase money by farming only; a little over 5 per cent earned it in other business. These figures show that the purchase of a farm has been mostly undertaken to enlarge a farm which according to the survey was usually a small piece of inherited land.

6. Of the farmers under survey, 71.7 per cent derive all their income from the farms; 28.3 report income from other business. Of the latter, 8.5

per cent derive half or more of their income from the farm; and 19.8 per cent derive from their farms less than half of their income.

7. Fifty-six per cent of all the farmers report a surplus over expenses, and 44 per cent report no surplus. Only 53.2 per cent of all farmers reported any savings. A surprisingly low percentage, 1.8 per cent, reported having made investments in farm improvements; these investments were small.

8. On the subject of experience of farmers previous to the acquisition of the farms, the results of the survey show the following:

(*a*) Those having had no experience on farms except with their fathers were 89.7 per cent. This group attained ownership without any independent experience in farming.

(*b*) There were 1.6 per cent who were farm laborers for an average period of 7.3 years prior to ownership.

(*c*) Those who had worked as tenant farmers for an average period of 12.5 years before owning land formed 3.3 per cent

(*d*) Of the whole number, 3.6 per cent had been in other occupations for almost eight years before achieving ownership.

9. It was found that the average age at acquisition of a farm, showed gradual increase from decade to decade, starting with an average age of 20.3 years for 1870 to 1879 and ending with 24 years for 1920 to 1928. Men gaining ownership today are older than those of five or six decades ago.

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TABLE 1

Methods of acquisition of farms

TOWNS	BY INHERITANCE	BY GIFT	BY MARRIAGE	BY PURCHASE FROM		TRANSACTIONS	FARMS ACQUIRED
				relative	others		
Binalonan	56	3	15	21	33	128	72
Mangaldan	74	4	24	32	33	167	80
Pozorrubio	65	1	21	20	32	139	80
San Carlos	69	—	23	39	34	165	77
Urdaneta	71	1	17	20	34	143	80
Total	335	9	100	132	166	742	389
Percentage of transactions	45.1	1.2	13.5	17.8	22.3	—	—

TABLE 2

Showing change of ownership of farms in the six decades since 1870 and the number of farms involved and the method of change

DATE	INHERITANCE	GIFT	MARRIAGE	PURCHASE FROM		TOTAL TRANSACTIONS REPORTED	TOTAL FARMS ACQUIRED
				relative	others		
1870–1879	3	—	—	1	2	6	3
1880–1889	23	—	5	9	13	50	25
1890–1899	87	1	24	42	58	212	92
1900–1909	73	2	16	30	40	161	79
1910–1919	85	4	32	33	43	197	110
1920–	64	2	23	17	10	116	80
Total	335	9	100	132	166	742	389

TABLE 3

Persons who inherited farms

TOWNS	FARMERS' SONS	NON-FARMERS' SONS	TOTAL	WORKED WITH FATHER	DID NOT WORK WITH FATHER	AVERAGE AGE AT SEPARATION	AVERAGE AGE AT ACQUISITION OF FARM
Binalonan	53	3	56	43	13	22.7	22.7
Mangaldan	71	3	74	47	27	22.0	22.0
Pozorrubio	63	2	65	51	14	21.1	21.1
San Carlos	59	10	69	47	22	22.9	23.2
Urdaneta	67	4	71	56	15	21.4	21.7
Total	313	22	335	244	91	22.0	22.1

TABLE 4

Acquisition of purchase money

TOWNS	INHERITANCE	GIFT	EARNED BY		TOTAL NUMBER REPORTING
			farming	other business	
Binalonan	—	—	37	4	41
Mangaldan	—	—	44	1	45
Pozorrubio	—	1	41	2	44
San Carlos	—	—	44	2	46
Urdaneta	—	—	39	2	41
Total	—	1	205	11	217
Percentage	—	0.5	94.5	5	—

TABLE 5

Sources of income and proportion of income derived from farm

TOWNS	FARMS REPORTING	REPORTING INCOME FROM OTHER BUSINESS	INVESTMENTS	FARMING ONLY BUSINESS	PROPORTION OF INCOME FROM FARM			
					All	Half or more	Less than half	None
Binalonan	72	24	—	48	48	—	24	—
Mangaldan	80	27	—	53	53	11	16	—
Pozorrubio	80	9	—	71	71	6	3	—
San Carlos	77	23	—	54	54	10	13	—
Urdaneta	80	27	—	53	53	6	21	
Total	389	110	—	279	279	33	77	—
Percentage	—	28.3	—	71.7	71.7	8.5	19.8	—

TABLE 6

Savings and proportion of surplus invested in farm improvements

TOWNS	NUMBER OF REPORTS	NO SURPLUS REPORTED	REPORTING SURPLUS ONLY	PROPORTION INVESTED IN FARM IMPROVEMENTS				REPORTING SAVINGS
				All	Half or more	Less than half	None	
Binalonan	72	40	32	—	—	—	—	29
Mangaldan	80	32	48	—	—	1	—	45
Pozorrubio	80	35	45	—	—	—	—	43
San Carlos	77	26	51	—	—	3	—	51
Urdaneta	80	38	42	—	—	3	—	39
Total	389	171	218	—	—	7	—	207
Percentage	—	44	56	—	—	1.8	—	53.2

TABLE 7

Experience of 389 Pangasinan farmers prior to farm ownership

GROUP	PERCENTAGE	NUMBER	AVERAGE AGE AT LEAVING FATHER'S BUSINESS	AVERAGE NUMBER OF YEARS EXPERIENCE			AVERAGE AGE WHEN FARM WAS OBTAINED
				as farm hand	as tenant	in other business	
1. No experience on farms except with father							
All	89.7	349	21.9	—	—	—	21.9
Farmers' sons	—	327	21.8	—	—	—	21.8
Non-farmers' sons	—	22	22.9	—	—	—	22.9
2. Farm laborers only							
All	1.6	6	18.5	7.3	—	—	25.8
Farmers' sons	—	4	19.0	7.8	—	—	26.8
Non-farmers' sons	—	2	17.5	6.5	—	—	24.0
3. Tenants only							
All	3.3	13	21.0	—	12.5	—	33.5
Farmers' sons	—	13	21.0	—	12.5	—	33.5
Non-farmers' sons	—	—	—	—	—	—	—
4. Business other than farming							
All	3.6	14	21.4	—	—	7.9	29.3
Farmers' sons	—	10	21.0	—	—	8.8	29.8
Non-farmers' sons	—	4	22.5	—	—	5.5	28.0
5. Laborer and tenant							
All	0.8	3	18.7	2.0	6.0	—	26.7
Farmers' sons	—	3	18.7	2.0	6.0	—	26.7
Non-farmers' sons	—	—	—	—	—	—	—
6. Laborer and other business							
All	0.5	2	19.0	3.5	—	6.5	29.0
Farmers' sons	—	2	19.0	3.5	—	6.5	29.0
Non-farmers' sons	—	—	—	—	—	—	—
7. Tenant and other business							
All	0.5	2	18.0	—	7.5	7.0	32.5
Farmer's sons	—	2	18.0	—	7.5	7.0	32.5
Non-farmers' sons	—	—	—	—	—	—	—
Average	100	—	19.6	4.3	8.7	7.1	22.0

TABLE 8

Showing by decades average age at acquisition

DECADE	NUMBER OF FARMS ACQUIRED	AVERAGE AGE AT ACQUISITION OF FARMS
1870–1879	3	20.3
1880–1889	25	20.9
1890–1899	92	21.3
1900–1909	79	22.7
1910–1919	110	22.9
1920–1928	80	24.0
Total	389	(Average) 22.0

ABSTRACT[1]

The effect of the season upon the production of rice. Evaristo Gotera. (*Thesis presented for graduation, 1926, with the degree of Bachelor of Science in Agriculture, from the College of Agriculture No. 314; Experiment Station contribution No. 659*).—This study was conducted in the College of Agriculture, Los Baños, Laguna. The paper gives the general description of the effect of the season upon the production of rice. The author used Apostol, a lowland variety of rice, in his experiments. The seedlings were grown in seed beds and were pulled up when three weeks old. They were transplanted at distances of 25×25 centimeters in a permanent field previously prepared. A slow current of irrigation water was maintained throughout the growing season. The crop was harvested by a native method.

The author ran twelve cultures at different times and reported the following results: The rice seedlings transplanted on July 4, 1926, gave 23.08 per cent of undeveloped grain; on August 9, 33.56; on September 13, 35.71 per cent. The crop was damaged by the rice bug, atañgias, and rice borers. The seedlings transplanted on September 24, November 2, and 20, January 10, and February 10 were not profitable because they were attacked by atañgias, mayas, and rats. The last two sets of cultures were affected by the drought. The atañgias, mayas, and rats were not prevalent from March 20 to June 13. The seedlings transplanted on March 20 gave 20.55 per cent of undeveloped grain; on April 14, 5.94; on May 16, 5.95; on June 13, 8.61 per cent.

The yield of grain and straw was correlated with the length of the vegetative growth of the rice. The author found that the longer the vegetative growth of the rice plants from sowing to flowering the greater the yield of grain and straw. When the field was irrigated, rainfall had no effect upon the growth of the plants and the yields of grain and straw. The higher the temperature of the air, soil, and water and the greater the total evaporation during the favorable season, the greater the yield of grain and straw.

The atañgias were prevalent and destructive to the developing grain from March to December, mayas from January to October, and rats from July to November. Rice borers were not so destructive as the other pests mentioned but they did slight damage from July to February.

—Abstract by Servillano G. Gutierrez.

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[1] Abstract prepared as part of required work in English 6, College of Agriculture.

EXCHANGE NOTES

The establishment of a Co-operative Land Mortgage Bank and Local Land Mortgage Societies will, it is expected, go a long way to help the indebted Agriculturists who have been pleading for such measure of relief. The proposed Bank is in the nature of a big experiment, at least so far as this country is concerned. How far it will prove of real benefit to the agricultural population will depend upon the care and caution with which the scheme is worked in its early stages and the response it receives not only from the agriculturist classes but also from the well to do among the non-agriculturists. As the scheme is now designed, it is expected to render assistance to the middle class agriculturists. Big landlords who are in a position to command sufficient credit do not come within its purview, nor can the Bank help a raiyat [tenant] who has rendered his position irretrievable by having mortgaged his credit to the hilt.

—*Mysore Agricultural Calendar, 1930* (India).

A newly-invented German machine, designed to do for Occidental grain fields what Chinese coolie labor has done for centuries in the rice fields of the East, is attracting considerable attention on the part of British agriculturists. Instead of sowing seed like an ordinary grain drill, it sets out sprouted and rooted seedlings at the rate of 12,000 plants per hour, one to every square foot. It is claimed that this method of raising grain requires only one thirtieth as much seed as now used, and that it will yield from three to five times as many bushels to the acre. This is said to be the result of the greater freedom each plant has to develop a more vigorous root growth beneath the soil, and especially to tiller, or "stool out," above its base. From 30 to 40 stalks per plant are usually developed.

—*Science.*

Foods rich in vitamins are available to housewives all the year around. Canned tomatoes are good vitamin-supplying food and lend themselves to variations in their preparation. Cabbage, onions, carrots, rutabagas, and parsnips are also rich in some of the vitamins. Apples, bananas, oranges, and grape-fruit are also good and are rich in vitamins.

—*Breeder's Gazette* (Chicago).

Who does not remember the harsh things said of the prickly pear during the past quarter, if not half, century? How black it was painted, how denounced to be dug up and exterminated in every way possible. What "tons" of money and effort have been expended in doing so.

Yet to-day, behold, what a change! That which was black and evil is now claimed to be white and good. We refer to the report via the Johannesburg correspondent of the *London Mo:ning Post*, of December 2nd, that a flock of 800 sheep on the Government farm at Graaff Reinet to-day had their first drink of water for three years, but many, having lost theii taste for it, turned away disgusted.

These sheep have been the subjects of prolonged experiment as drought-resisting animals, and during the whole period they have been fed on oilcake and prickly pear only, without any form of liquid.

It has been found that prickly pear, which hitherto has been regarded as a grave menace to farmers in South Africa and Australia, where thousands of acres have been ruined by it, contains all the necessary moisture to sustain livestock indefinitely.

During the three years, lambing and the wool yield have been perfectly normal.

—*Tropical Life.*

The farmer should keep pace with the trend of civilization; he should read regularly, to become acquainted with the best methods, and adapt himself to constantly changing circumstances. Production should be increased and costs of labour decreased; in order to obtain best results, the most modern inplements and methods of cultivation are necessary.

—*Farming in South Africa.*

Inquiries made in 47 countries by the International Committee for the Protection of Childhood reveal, according to reports from Geneva, that the admission of minors to cinemas and the choice of films to be shown to children are subject to special regulations in 31 countries. In most of the countries the films prohibited to youth belong to the same category—that which is considered to have a pernicious influence on the morality of young people or to be dangerous to the imagination of children owing to scenes of passion or crime depicted therein.

—*Commerce Reports* (Washington, D.C.)

Last week two poultry dealers in Sparks, Nevada, received 47,000 baby chicks and only four dead in the lot. . .

—*California Cultivator.*

Egypt is an important consumer of fertilizers, and year by year the consumption will increase. Stable manure is rare, as cattle in the country is not abundant and camel manure is used as fuel. The increased use of motor tractors for agricultural purposes in the place of cattle, donkeys, and camels will further reduce the supply. Also the use of the ruins of ancient villages (Koms) as manure is decreasing, as this manure is not very rich in fertilizing matter and the cost of its transport to the field is often very heavy and disproportionate to its value.

The soil of Egypt requires nitrogen, phosphoric acid, and potash.

—*The Cyprus Agricultural Journal.*

A poultry night school at Turlock, Stanislaus County, started with 64 attendants. . .

—*California Cultivator.*

COLLEGE AND ALUMNI NOTES

Dean Gonzalez, Doctors Villegas, Mondoñedo, Fronda, and Manresa, and Messrs. Taleon and Esguerra, of the Animal Husbandry staff, made an interesting trip recently to Jalajala, an old town in Rizal Province. This town which is located on the shores of Laguna de Bay is of historic and romantic interest as it is the site of the large estate developed over a century ago by Monsieur La'Gironière.

But to the men on this trip the romantic tale of this estate long ago reclaimed by the jungle from which La'Gironière wrenched it, was of secondary interest They were seeking information about the Jalajala hog, which is the foundation of the Berkjala hogs being developed in the College.

Through the courtesy of the Limnological Station the trip was made comfortably and expeditiously in the station's new motor boat.

Dr. F. O. Santos lectured on Nutrition to the Nurses of the Philippine Chapter of the Red Cross, April 10, 1930, and on the same subject to the Nurses of the Public Welfare Commission on May 2, 1930.

Doctor Santos spent several days during the summer recess in Calapan, Mindoro, studying the diet of the people suffering from "lapnus".

Professor Reginald H. King, accompanied by his wife and daughter, spent several days of the summer vacation in Baguio.

On the registration for the first semester, the Secretary made the following report on June 11:

Total number of students registered	711
1. New Students:	
Freshmen (regular)	143
Special Students	8

2. Cross-registrants:		
	a. From the Rural High School (Graduates from Agricultural Schools)	25
	b. From the College of Veterinary Science	76
	c. From the School of Forestry	1
3. Woman Students:		
	a. New Students	12
	b. Old Students	8

Thongdee Resanant, B. S. A. '24, in a recent letter to Doctor Fronda writes interestingly of his work with poultry in the Agricultural Teachers' Training School at Tap Ouang, Siam. Prevalence of disease, parasites, and lack of animal protein feed, the bugbears of all poultry men, are part, apparently, of the "daily dozen", that is developing Resanant's endurance. Last year seven hundred ducks gave a balance on the wrong side of the ledger. This year, Mr. Resanant will try ducks again with meat the object. The School chicken flock includes Leghorn and Rhode Island Reds. It is uphill work to introduce Leghorns, Mr. Resanant writes, because the Siamese have an aversion to eating white chickens.

Mr. Resanant was made principal of the School last year. With him are Charas Sundarasinha and Roem Purnariksha, both B. S. A. '28.

Apparently in Siam there is the lack of public and official interest in the development of modern agriculture and the consequent very limited appropriation for the agricultural schools that is found in so many countries. But, judging from the tone of his letter, Mr Resanant is facing the situation with his usual pluck and good sense.

Mr. Leopoldo Villanueva, pensionado in Sugar Technology, obtained the degree of Master of Science from the Louisiana State University and Agricultural and Mechanical College, in August, 1929. He is at present taking advanced courses in Agricultural Engineering.

For the purpose of studying the nutrition of the Filipino Olympic athletes, Mr. Esteban G. Collado, instructor in Agricultural Chemistry, stayed in the training camp of the athletes in Manila and accompanied the team to Japan.

Mr. Ramon P. Tolentino, Jr., B. S. A. '24, instructor in Physical Education in the College, joined the ranks of the Benedicts on April 30. His bride was Miss Milagros Mañagas.

Mr. Quintin Eala, B. S. A. '30, College Librarian, and Miss Pacita Carandang were married March 26.

Mr. Feliciano Pantaleon, B. Agr '28, Assistant in Plant Physiology, and Miss Josefina Quesada were married in Paete, Laguna, on April 20.

Mr. Moises Kalaw, B. S. A. '26, is on the faculty of the U. P. branch which is this year opened in Vigan, Ilocos Sur. Mr. Kalaw is instructor in botany.

Mr. Francisco Barros, Assistant in Chemistry, was transferred to the Department of Agricultural Education, effective June 1, 1930.

Mr. Enrique Lopez, B. Agr. '23, was a recent campus visitor.

Photographic Division, College of Agriculture

FRANK LINCOLN STEVENS

Professor of Plant Pathology, University of Illinois, and Charles Fuller Baker Memorial Professor, University of the Philippines

FRANK LINCOLN STEVENS: FIRST CHARLES FULLER BAKER MEMORIAL PROFESSOR OF THE UNIVERSITY OF THE PHILIPPINES[1]

Doctor Frank Lincoln Stevens, Professor of Plant Pathology of the University of Illinois at Urbana and first incumbent of the Charles Fuller Baker Memorial Professorship (1930–1931 in Plant Pathology) in the College of Agriculture, University of the Philippines, arrived in Manila on June 23, 1930, accompanied by Mrs. Stevens. Immediately upon arrival Doctor Stevens reported for duty at the College of Agriculture at Los Baños.

During his two semesters of residence at the College of Agriculture, Doctor Stevens will give two formal courses on the Morphology and Taxonomy of Parasitic Fungi. In addition to these courses he will conduct the seminar, do research work on entomogenous fungi, and advise members of the staff in their research activities.

FRANK LINCOLN STEVENS

Degrees

B. L., Hobart College, Geneva, New York, 1891
B. S., Rutgers College, New Brunswick, New Jersey, 1893
M. S., Rutgers College, 1897
Ph. D. (Botany and Bacteriology), University of Chicago, June, 1900
D. Sc., University of Lima, San Marcos, Peru, 1924
LL. D., University of Glasgow, Scotland, 1928.

Positions held

Traveling Fellow, The University of Chicago (Bonn, Halle, Naples; Smithsonian Institution table at Naples), 1900-1901; Instructor in Vegetable Pathology, North Carolina College of Agriculture and Mechanic Arts, West Raleigh, North Carolina, 1901-1902; Professor of Botany and Vegetable Pathology, and Pathologist of the North Carolina Agricultural Experiment Station, 1902-1912; Dean, Porto Rico College of Agriculture and Mechanic Arts, Mayagüez, Porto Rico, 1913-1914; Professor of Plant Pathology, University of Illinois, Urbana, Illinois, 1914——.

Membership in societies

Fellow of the American Association for the Advancement of Science; Member, American Breeders' Association; Member, American Mycological

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[1] General contribution from the College of Agriculture No. 270. Received for publication July 8, 1930.

Society; Member and Vice-President, American Nature-Study Society; Charter member and President, American Phytopathological Society; Member, Society of American Bacteriologists; Member, Society of American Naturalists; Member, Botanical Society of America; Member, Wisconsin Academy of Sciences, Arts, and Letters; Member, Illinois Academy of Science; Charter member and President (1905), North Carolina Academy of Science; Member, Sigma Xi; Member, Phi Beta Kappa; Associate Editor, Phytopathology and American Journal of Bacteriology.

Publications

Books

1906. Joint author with Mrs. Stevens. Agriculture for beginners. Ginn and Company, New York.

1910. Joint author with Mrs. Stevens. The Hill Readers. 7 volumes. Ginn and Company, New York.

1910. Diseases of economic plants. The Macmillan Company, New York.

1911. Joint author with Mrs. Stevens. Practical arithmetic. Charles Scribner's Sons.

1919. The fungi which cause plant disease. The Macmillan Company, New York.

1921. Diseases of economic plants. Revised. The Macmillan Company, New York.

1925. Plant disease fungi. The Macmillan Company, New York.

In addition to the books listed above Doctor Stevens is author of many scientific papers. He has published many articles from 1896 to 1915, but as we have no access to these they are not included in the list. Of the publications during the period from 1896 to 1915 the most important ones are those which deal with the cytology of fungi, diseases of plants and soil bacteriology. Most of the papers published by Doctor Stevens from 1915 to the present time are here listed:

Papers (journal reprints, bulletins, circulars, etc.)

1915. A convenient little known method of making micro-mounts of fungi. Phytopathology.
The genus Meliola in Porto Rico. Illinois Biological Monographs.
Collecting plants in Porto Rico. Journal of the New York Botanical Garden.
Noteworthy Porto Rican plant diseases. Phytopathology.
Some new strawberry fungi. Phytopathology.

1917. Observations on pear blight in Illinois. Transactions of the Illinois State Horticultural Society.

1918. Bacteriology in Plant Pathology. Transactions of the American Microscopical Society.
Problems of Plant Pathology. Botanical Gazette.
Spegazzinian Meliola types. Botanical Gazette.
Some meliolicolous parasites and commensals from Porto Rico. Botanical Gazette.
Porto Rican fungi, old and new. Tenth Annual Report of the Illinois Academy of Science.

1919. Two Illinois rhubarb diseases. Illinois Agricultural Experiment Station Bulletin 213.
Plant Pathology Laboratory Outlines. Lloyd's University Store.
Protect the wheat crop. Eradicate the common barberry from Illinois. Illinois Agricultural Experiment Station, Extension Circular 22.

Pear blight wind borne. Science.
New or noteworthy Porto Rican fungi. Mycologia.
Observations on pear blight in Illinois. Transactions of the Illinois Horticultural Society.

1920. Three new fungi from Porto Rico. Mycologia.
An apple canker due to Cytospora. Illinois Agricultural Experiment Station Bulletin 217.
Foot rots of wheat—Historical and bibliographic. Illinois Natural History Survey.
Perithecia with an interascicular pseudo-parenchyma. Botanical Gazette.
Report on literature regarding wheat foot-rot. Report on the Conference of Cereal Pathologists of America, June 5, 1917.
A parasite of the tree fern (Cyathea). Botanical Gazette.
Black spot of onion sets. Illinois Agricultural Experiment Station Bulletin 220.
Some Phyllachoras from Porto Rico. Botanical Gazette.
Foot rot of wheat. Science.

1921. Dothideaceous and other Porto Rican fungi. Botanical Gazette.
Crop diseases. Illinois Farmers' Institute Report.
New or noteworthy Porto Rican fungi. Botanical Gazette.
The genus Septoria presented in tabulation with discussion. Transactions of the Illinois Academy of Science.
Byron David Halsted. American Journal of Botany.

1922. Plant disease and human welfare. American Journal of Botany.
The Helminthosporium foot-rot of wheat, with observations on the morphology of Helminthosporium and on the occurrence of saltation in the genus. Division of Natural History Survey.

1923. Notes on Hawaiian botany with special reference to fungi. Transactions of the Illinois Academy of Science.
Merulius lachrymans as the cause of rot of asphalt shingles. Phytopathology.
A Meliola disease of cocoa. Phytopathology.
1924. Three new Myriangiaceous fungi from South America. Mycologia.
1925. Parasitic fungi from British Guiana and Trinidad. Illinois Biological Monthly.
1926. Hawaiian fungi. Bernice P. Bishop Museum Bulletin 19 (Honolulu, Hawaii).
Regarding the curing of cacao. Trinidad Department of Agriculture Bulletin.
Species of Meliola and Irene from British Guiana and Trinidad. Mycologia.
The Hemispheriaceae of British Guiana and Trinidad. Botanical Gazette.
Tulip blossom blight. Illinois Agricultural Experiment Station Bulletin 265.
Corrugated aluminum sheets for the botanist's press. Botanical Gazette.
Tropical fungi of the Western Hemisphere. Abstract Journal of Science Transactions British Association for Advancement of Science.
Fungi of Costa Rica and Panama. Illinois Biological Monographs.
Sorosphera and kindred genera. Mycologia.
A monograph of the Meliolineae. Annales Mycologici.
Some Meliolas from India. Journal of Botany, India.
The use of the terms "Saprophyte and Parasite." Phytopathology.

In press

The response to ultra-violet irradiation shown by various races of *Glomerella cingulata.* American Journal of Botany.
The ascigerous stage of *Colletotrichum lagenarium* induced by ultra-violet irradiation. Mycologia.
The effects of ultra-violet irradiation on various Ascomycetes, etc. Centralblatt f. Bakt., etc.

Relation of nutrients to perithecial production under ultra-violet irradiation. The Philippine Agriculturist.

A comparative study of *Sclerotium rolfsii* and *Sclerotium delphinii*. Mycologia.

The reaction of various Sclerotium races with other fungi. Transactions of the American Microscopical Society.

Parasitic fungi of British Guiana, Trinidad, and Costa Rica. Annales Mycologici.

Parasitic fungi from Panama. Annales Mycologici.

Parasitic fungi of Peru and Ecuador. Annales Mycologici.

Further observations regarding ultra-violet irradiation and perithecial development. In manuscript for publication in the Philippine Agriculturist.

From the list of publications given above one will readily see that Doctor Stevens is a very prolific writer. The list of the books written by Doctor Stevens shows that he is not only well versed in the fungi and plant diseases but he also has a very broad training in related sciences. From the list of journal publications one can see how much work Doctor Stevens has done in pure and applied mycology.

Doctor Stevens is well acquainted with the fungous flora of tropical countries, having been to the West Indies, Central America, South America, Hawaii, and other regions. In the West Indies Doctor Stevens founded the College of Agriculture of Porto Rico.

Doctor Stevens has very kindly consented to give, during his incumbency as Charles Fuller Baker Memorial Professor, eight semi-popular lectures on various topics bearing on his work and travels. Most of these lectures will be illustrated with lantern slides. These lectures will be given under the auspices of the Committee on Social Affairs of the College of Agriculture.

G. O. Ocfemia,
Of the Department of Plant Pathology.

RANCHING IN BUKIDNON[1]

MIGUEL MANRESA
Of the Department of Animal Husbandry

In the northeastern part of Mindanao on a high plateau lies the inland province of Bukidnon. It is bounded on the north by the province of Misamis Oriental, on the east by Agusan and Davao, on the south by Cotabato, and on the west by Lanao and Misamis Oriental. In the central part of the province rise the beautiful Kitanglad and Kalatungan Mountains, completely surrounded by rolling lands. Deep canyons cut these lands into areas varying in size from several hundred to a few thousand hectares. For the most part, this land is open grass land traversed by rivers with numerous branches. Because of its elevation, the average temperature in the whole province is lower than the average temperature in the Philippines (Pineda, 1926), thus making the province highly suitable for grazing purposes.

Very little was known of Bukidnon until the present century. Up to as late as 1908 a considerable portion was unexplored. It seems to be generally agreed that prior to that year there was no live stock of any importance in Bukidnon. To Mr. Manuel Fortich, former lieutenant governor, belongs the credit of having introduced cattle raising as a business. It was he who in 1909 (Davis, 1930) drove the first herd of cattle through Bukidnon. In 1912 he brought in some Indian cattle. About this time the Diklom Ranch which started as the Agusan Coconut Corporation brought in some cattle which were kept on the hillsides. Finding that the cattle throve well the corporation in 1914 opened a large ranch. Several people became interested in the project. Mr. Teofilo Alvarez opened his ranch in 1914 with only four head. In 1915, Mr. Melecio Alquitela brought in fifteen breeding females and one male. Two years later the government opened the Crescent Star Cattle Corporation at Dagumba-an under the management of Mr. Florentino Cruz. This government enterprise was a

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[1] Experiment Station contribution No. 662. Received for publication July 7, 1930.

Most of the data contained in this report were gathered personally from actual observation and from the live stock owners themselves during a visit of two months in Bukidnon from March 21 to May 19, 1930. It is with a deep feeling of gratitude that the writer expresses his thanks to the ranchers in Bukidnon who provided every opportunity to learn the details of the operations of their ranches. To the managers of the Diklom Ranch, Mercedes Ranch, and Pepita Ranch, and to former Governor Manuel Fortich, Dr. Carlos A. H. Fortich, Mr. Florentino Cruz, and the Tuason Brothers special thanks are due for the splendid hospitality they extended.

boon to the cattle industry as many ranches could be supplied with Indian breeding bulls from this herd. Among other pioneer ranches are the San Lorenzo Ranch owned by Mr. Teofilo Alvarez, Angeles Ranch owned by Mr. Marcelino Angeles, Pepita Ranch owned by Mr. Teopisto Guingona, former senator from Mindanao and Sulu, and the Nellore Ranch established by Hon. Dean C. Worcester, former Secretary of the Interior. The Nellore Ranch is still a part of the Worcester Estate.

According to the Philippine Census of 1918 there were, in 1917, 4,960 head of cattle in Bukidnon. Very conservative estimates show that in December, 1929, over 46,000 head of cattle were in the province. These cattle, in herds varying in size from about one hundred to ten thousand head, are on well organized ranches. The aggregate number of cattle owned by people having fewer than 100 head is less than 2500, showing that large herds predominate.

ESTABLISHED CATTLE OWNERS IN BUKIDNON

The following is a list made in December, 1929, of the established cattle ranches in Bukidnon, names of owners, location, and the approximate number of cattle in herd:

OWNER OR MANAGER AND NAME OF RANCH	LOCATION	APPROXIMATE NUMBER OF ANIMALS
1. José Aguado	Imbatug	500
2. Agusan Coconut Co., Diklom Ranch: Superintendent, B. B. Brown	Diklom	10,000
3. Melecio Alquitela, Carmen Ranch	Libona	170
4. Sabino Q. Ami	Salawangan (Maramag)	200
5. Marcelino Angeles	Maluko	400
6. Barrera Brink	Malitbog	500
7. Francisco Briones	Imbatug	100
8. Jaime Buenaflor	Talakag	30
9. Teofilo Galiñgasan	Libona	150
10. José Carrillo	Malaybalay	50
11. Clemente Chaves	Maasim, Nicdao	500
12. P. S. Cerna	Kibaroc (Malaybalay)	200
13. Toribio Coruña	Maramag	200
14. Florentino Cruz, Pioneer Ranch	Hagkol	1,000
15. Santos Cudal	Manupali (Bugcaon)	400
16. Kenneth E. Day	Libona	1,800
17. Dr. Mamerto Escaño	Opalon	300
18. Dionisio Fabella	Imbatug	550
19. Gov. Manuel Fortich, Fortich Ranch; Manager, Dr. C. A. H. Fortich	Dalirig, Kilabong and Opalon	3,000
20. José Fuentes	Alalum (Impasugong)	300
21. Ignacio Gamoy	Alanib	70
22. Dr. Ralph M. Gearhart	Santa Fe	1,000
23. Capt. C. I. M. Javier	San Luis	300
24. Anastacio Limbo	Maramag	250
25. Alejandro Lina-ac	Imbatug	200
26. Dr. Jose Marfori	Mapawa	600
27. Capt. V. A. Mata	Miuban (Maramag)	80
28. Juan P. Melendres	Canayan (Malaybalay)	150
29. Godofredo Monsod	Libona	90

30. José Tan Neri	Linabo	200
31. Major M. Nicdao	Baungon	200
32. Amado Noble	Talakag	400
33. Albino Noble	Talakag	800
34. J. Ozamis	Kiokong (Maramag)	500
35. Gabino Palabino	Kalasungay	100
36. Dick Paradies, Jr.	Maramag	500
37. Cenon Paulican	Maramag	100
38. Teopisto Guingona, Pepita Ranch	Impasugong	1,900
39. Emilio Pineda	Pañgol	200
40. Mauricio Quirab	Kalawaig	50
41. Capitan Ramon	Punti-an	40
42. Roces and Co., Mercedes Ranch: Manager, José G. Sanvictores	Dalwangan and Dabumbaan	4,300
43. Gov. Pascual Rubin, Musuan Ranch	Musuan	1,300
44. Teofilo Alvarez, San Lorenzo Ranch	Mailag	1,300
45. Basilio Sarmiento	Guinuyuran	200
46. Bukidnon Agricultural School	Managoc	200
47. Star Cattle Corporation	Imbatug	900
48. Marcelino Sulatan	Kalasungay	150
49. Daniel Sy Cip	Santa Fe	1,500
50. Guillermo Tabios	Lantapan	200
51. Apolinario Talatala	Malaybalay	30
52. Tuason Brothers	Talakag	450
53. Major B. D. Valeriano	Kulaman	400
54. José D. Valdez	Gamayar	70
55. Rep. Isidro Vamenta	Langa-an (Talakag)	200
56. Ramon Villanueva	Malaybalay	150
57. Col. O. Waloe, Waloe Ranch	Impalutao	1,500
58. Nellore Ranch, Dean C. Worcester Heirs: Manager, Florentino Cruz	Lurugan	4,000
59. Manuel Yia	Maramag	68
60. All small owners		2,000
Total		46,748

SYSTEM OF MANAGEMENT

The majority of the large ranches in Bukidnon are managed either by their owners or by members of the different cattle corporations. Some are run by hired managers or superintendents. A few are operated under the *encargado*[2] system. It may be stated with pardonable pride that, in general, the owners and managers of these ranches are men who understand the cattle business. They take great interest in their work.

The general plan of ranch management throughout Bukidnon is essentially the same. The entire herd is divided into three more or less general herds; namely, (1) breeding herd, or main herd consisting of the breeding cows with young calves; (2) heifer and young steer herd, consisting of heifers from about six months to two years of age, and the young steers; (3) the steer and young bull herd. These herds are usually placed in isolated pastures separated by natural barriers or by fences. The animals are inspected at frequent and regular intervals for the purpose of recording births, treatment of minor injuries, giving salt, etc. For the purposes of identification each ranch brands its animals. All male animals not needed for breeding purposes are castrated.

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[2] The word *encargado* means in charge. In this discussion "*encargado* system" means absentee ownership.

While in general the plan of management on the ranches is about the same, the details of carrying out this plan are very different. For example, in some ranches the herds are divided into smaller subherds of about five hundred animals; in others the herds are large and contain as many as three thousand head. Some ranchers allow one-half to one kilogram of salt a month to an animal; others only one-tenth of a kilogram or even less. Some managers gather all the animals in a definite place for salting, others carry the salt to any place on the range that the cattle may be found. Some brand every year, others twice a year, and there are those who brand any time they find that a sufficient number of cattle to be branded is available. Some castrate the animals while they are young, others later. Some apportion one bull to every ten females, others allow one to every fifty or even more. For fencing material some ranchers use freshly cut posts of quickly growing trees, such as madre cacao, *Gliricidia sepium*, ipil-ipil, *Leucaena glauca* (Pineda, 1926), kapok, *Ceiba pentandra* L., lumbago or pacnot, *Sterculia* sp., kamil, or wild kapok, *Bombax ceiba*, anii, *Erythrina* sp., or even narra, *Pterocarpus indicus* Willd; others use the dead wood of very hard and expensive trees as molave, *Vitex parviflora*, malibato or yacal, *Shorea* sp. On a number of ranches, bamboo posts are very common.[3]

In going over the different ranches one's attention is attracted by the corrals in which animals are gathered for special purposes, as separating into different classes or for counting. Where a large number of animals are handled these corrals are indispensable. In its simplest form the corral is a single enclosure which may be rectangular or with rounded corners, or oval in shape. In its modern form it is a complicated structure containing many compartments and costing several thousand pesos to build. These two forms and all the intergrades between are found in Bukidnon. When one has catching and separating corrals that are properly made, the routine work in the ranch is a pleasure.

The reason for this great diversity in the details of cattle management is to be found in the fact that the business of cattle management in Bukidnon is still very largely individualistic, that is, each manager or rancher believes that he has discovered the key or, to quote their word, the "secret"[3] to successful raising of cattle. Mr. Florentino Cruz believes that constant supervision, day and night if necessary, of each animal in the herd, and prompt attention to every detail of the work on the ranch is the way to ultimate success. He expressed this idea emphatically and laconically at a College of Agriculture student convocation on February 14, 1930. At the close of short talk to the students on ranching, a student asked Mr. Cruz what he considered the most important cause of mortality of animals on the ranch. "Negligence" was the reply. Mr. Cruz takes good care of his animals, but he does not stop there. If he had done nothing but to produce animals he would soon be among the total failures. But like most successful ranchers with keen powers of observation and good knowledge of cattle and their functions, Mr. Cruz has a keen sense in business matters. His policy is to sell his surplus steers as rapidly as he can, or as soon as he can get from 80 to 95 pesos a head for them.

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[3] Professor Edwin Emil Schneider of the College of Agriculture and Forester Alejandro de Mesa of the Bureau of Forestry were consulted as to the scientific names of these trees.

An entirely different system is practiced by the Tuason Brothers. These men break all their steers for work on the ranch. They contend that by doing this the animals become tame and respond to care and feeding more readily than the wild unbroken steers. After these work steers have passed the peak of usefulness in the field they are fed intensively and are sold for beef. The Tuason Brothers believe that this system will enable them to get the highest returns from their animals. In selecting their breeding cows, these ranchers emphasize udder development. They attribute their success in raising every calf born on the ranch to the fact that their breeding cows have an abundant supply of milk.

Dr. Carlos A. H. Fortich, who is now managing his father's ranch at Kilabong says that the secret of successful ranching lies in the weaning of calves as early as possible. He believes that the highest efficiency in reproduction can be obtained by such a practice. Mr. Teofilo Alvarez expressed practically the same idea when he said that the ability to raise the largest percentage of the calves that are born is the secret of success in the cattle raising business.

It is quite obvious that the production of vigorous offspring is a primary requirement in any live stock project. It should be interesting therefore, to know what have been the percentages of increase on the different ranches under slightly different methods of handling the breeding herds.

REPRODUCTIVE EFFICIENCY

Very carefully kept records by Mr. José G. Sanvictores, manager of the Mercedes Ranch during a period of three years, show that somewhat in excess of seventy-five per cent of reproduction has been secured in Dagumbaan. On this ranch the heifers are not separated from the main breeding herd. Under such a system the heifers are bred just as soon as they become sexually mature.

Mr. Florentino Cruz, manager of the Nellore Ranch and owner and manager of the Pioneer Ranch, believes that the separation of the heifers into separate herds is essential for the production of offspring of the highest vigor. During the past ten years he has continuously maintained such a herd separately. Calves are weaned when about seven months old and all the heifers go to the weaning corral for about fifteen days. From there they go to the heifer herd. These heifers are not taken to the breeding herd until they are about 15 to 18 months of age. Mr. Cruz has not kept account of yearly increases so that the reproduction of his breeding herd can not be determined but the percentage of increase of the herd during the ten-year period can be computed from the figures given. Starting with about 300 breeding females in 1920 on the Nellore Ranch there are now over 4,000 animals in the herd and the company has sold in all 934 animals. This makes the total number of animals raised on the ranch at least 4,934. If all these original females had reproduced regularly one calf every year divided into an equal number of males and females, and if the female offspring had dropped calves at the age of 2½ years, on the average, and provided that all the calves born had lived there would be the total of 7,089 animals in the herd at the end of the ten-year period. The actual number of animals realized is 4,934 giving a percentage of increase of about 70 per cent (exact 69.6 per cent).

Dr. Carlos A. H. Fortich claims that during the past two years in which he has managed his father's ranch at Kilabong he has succeeded in obtaining a reproductive efficiency in cows of not less than 90 per cent. He attributes this to early weaning of the calves. By periodical removal of the bulls from the breeding herd he found it possible to have the cows calve during one breeding season. Actual counts at such seasons have shown that at least 90 per cent of the cows are followed by their calves.

The Tuason Brothers have not concerned themselves so much with figures and like Mr. Cruz have paid particular attention to the details as to care and management of every animal in the herd. Starting with 90 breeding females four years ago, these pioneers now have not less than 450 animals on their ranch. On the assumption that these females have reproduced at the same rate as those on the Nellore Ranch there would be in all 495 animals in the herd. But as there are only 450, the increase in the herd has been approximately 90 per cent.

The most comprehensive data on reproductive efficiency of breeding cows is that of the Diklom Ranch. The percentages of reproduction of cows on this ranch have been computed during a period of eleven years for pure Indian and grade Native or Hereford Indians and the results of this computation are shown in the following tabulation:

Percentage[a] *of reproduction among cattle in the Diklom Ranch,*[b]

YEAR	PURE INDIAN	AGUSAN HERD GRADE OR MESTIZO	ABOITIZ HERD GRADES	MARTIN HERD GRADES
1919	35.9	39.5	40.6	
1920	35.4	24.8	41.9	22.2
1921	71.0	51.0	45.0	——
1922	73.7	72.5	56.4	76.1
1923	54.9	84.0	81.5	84.7
1924	76.4	70.2	72.1	79.5
1925	68.7	73.0	70.4	80.9
1926	62.2	63.7		
1927	43.7	59.6		
1928	25.0	58.7		
1929	29.0	54.0		
Average	52.35	59.17	58.4	68.7

[a] These percentages are based on net increase and not on calves born.

[b] From annual report of Mr. N. S. Saleeby, Vice-President and General Manager of the Agusan Coconut Company, to the trustees for the Bukidnon Associates on the holding in the Philippine Islands for the year 1929.

In the above computations female cattle that are under three years of age are considered heifers. These were excluded from the computations. It may be seen from this table that on the average the Indian cattle are poorer producers than the grades. The average reproduction among Indian cattle is only 52 per cent, while the grades in Agusan, Aboitiz and Martin ranches are 59, 58 and 68 per cent, respectively. It may be noted from this table that the percentage of increase in the grade herds is very low during the first two or three years; the reason is that the Indian cattle are too large while Natives are too small. When these animals are crossed the percentage of *dystokia* is generally large owing to the large size of the fetus, consequently, deaths are frequent. But as the number of grade females in the herd increase, deaths among the offspring become less. The low rate of reproductive efficiency during the later years may readily be explained if we assume that the herd has become saturated with the blood of the Indian cattle because of grading up.

CROSSBREEDING

The outstanding thing that characterizes the cattle of Bukidnon today is the predominance of crossbred animals possessing the blood of at least two different breeds of cattle; namely, the Native and the Indian. Recognizing the immediate beneficial effect of crossing, the ranchers of Bukidnon have attempted, to a limited extent, to incorporate the blood of other breeds, such as Hereford, Ayrshire, and Shorthorn. As to the Native-Indian cross, it appears to be the experience of the majority of the ranchers that the first cross is usually a very desirable animal possessing the size and the thriftiness of the Indian and the gentle temperament and the superior beef qualities of the native stock. But as further crosses are made or when these crossbred females are bred to the pure Nellore fathers, the offspring resulting therefrom reverts to the leggy type of the Indian. When the crossbred animals are allowed to breed promiscuously great variability results and the production of undesirable types becomes apparent. Some ranchers have attempted to overcome this variability by further crosses with either Hereford or Ayrshire, but here again when succeeding crosses are made, greater variability follows. So variable are these animals that on ranches where five or six sub-crosses have been made the number of inferior individuals is considerable. Because of this fact the intelligent ranchers are beginning to see the need of devising a system of breeding that will enable them to produce animals of uniform type. This can be done provided they know the necessary combination.

MARKETING

Surplus stock must be sold or disposed of for the purpose of getting financial returns and for the improvement of the stock. On most ranches in Bukidnon there is still ample room for more animals; hence all the females are retained so as to increase the herds to a safe maximum capacity. At present the bulk of the surplus stock are the steers. There are two ranches, however, the Diklom and the Nellore that are overstocked. These ranches maintain a herd of pure Indian cattle, and they have been selling not only pure bred animals but also male and female grades of all ages. The quotation of prices (Pineda, 1926) for the sale of animals on the Diklom Ranch for 1925 is as follows:

Grade heifers	₱100 per head
Grade cows	150 per head
Pure Indian heifers	150 per head
Pure Indian cows	200 per head
Pure Indian bull (1 year old)	150 per head
Pure Indian bull (2 years old)	280 per head

In 1928 these prices were reduced as follows:

Grade heifers	₱ 70 per head
Grade cows	100 per head
Pure Indian heifers	100 per head
Pure Indian cows	150 per head
Pure Indian bulls (1 year old)	100 per head
Pure Indian bulls (2 years old)	₱200 to 250 per head

Because of the recent drought in Bukidnon further reductions in price had to be made, thus:

Grade heifers	₱ 65	per head
Grade cows	50	per head
Pure Indian heifers	70	per head
Pure Indian cows	₱70 to 100	per head
Pure Indian bull (1 year)	100	per head
Pure Indian bull (2 years or over)	150–200	per head

Because of these reductions in price many new ranches were opened in the interior and a number of the older ones were augmented through purchase of animals from the Diklom Ranch. Even these attractive prices did not entirely solve the problem of overstocking on the Diklom and the Nellore ranches.

Because heifers and old cows when slaughtered for beef dress only from 30-38 per cent[4] and because it costs as much to bring them to Manila as the steers, the test or experiment of spaying old cows and young heifers of inferior quality was tried to determine if any advantage would result either in stimulating increase in size or in dressing percentage. These spaying trials carried out on the Diklom and the Mercedes ranches in April and May, 1930 on a large number of animals by the writer, and by Dr. Carlos A. H. Fortich on his own and the Nellore Ranches should give very conclusive results.

Steers are sold for beef and for work purposes. The bulk of the beef steers are shipped to the Manila market. Very little beef is consumed in Bukidnon. Buyers come at regular intervals and buy beef steers paying from 80 to 95 pesos a head, on the ranch. These steers are driven to the port of embarkation at Cagayan or Bugo; to either place the distance is considerable. At the port they are loaded on steamers. Many of the steers are wild and lose considerable weight before they are slaughtered in Manila, because they refuse to take feed during the trip.

Practically all the ranchers, particularly the Tuason Brothers, Governor Fortich, Messrs. Alvarez, Sanvictores, and Cruz train a large number of steers for work every year and keep an adequate number of them for work on their ranches. The greatest number of the work steers are sold to the sugar plantations. Dealers from Cebu and Iloilo make regular calls at Bukidnon to buy work animals. The price ranges from 150 to 200 pesos. These animals are shipped to Negros in lots of about 50 head. The demand has always been greater than the supply, not from lack of steers that can be trained for work but because ranchers believe that it does not pay to train steers for sale as work bullocks.

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[4] Information furnished by Mr. N. S. Saleeby, Vice-President and General Manager of the Agusan Coconut Company.

For this and for other reasons the Tuason Brothers do not sell their broken steers for work animals. They break all their steers for the disk plow to be used on their farm as long as the steers last for this work. After they have passed their usefulness as such, these animals are fed intensively and sent to Manila to be sold as beef cattle. These animals being tame readily respond to care and management and the shrinkage in transit is very little. Consequently the highest returns can be secured from such animals for work and for beef. This practice may pay at present because their herd is yet small. As the number of animals on the ranch increases it may not be found practicable to break all the steers.

BREAKING STEERS FOR WORK

A word or two regarding the different methods used in breaking steers in Bukidnon for work may be useful. Breaking a few relatively tame animals offers no great difficulty to the trainer. But when he has to break a large number of range cattle from year to year, he is forced to find a system of breaking that works with considerable rapidity and safety.

Two distinct systems are used for breaking steers in Bukidnon; namely, the "Cruz" and the "Cudal" system. In the Cruz system the steers are caught and are tied to very stout railings attached to three very strong posts. Usually two animals, one on each side of the railing, are treated at a time. Steers do not struggle so much when they are run in pairs. The steers are kept tied here with practically no food or water for about two days. On the third day they are offered some water and some feed and are approached gradually until they can be touched on every part of their body. Mr. Cruz says that the best time to start taming is at night when the steers are in recumbent position. He begins by touching the animals with a piece of cloth tied to the end of a long stick, and proceeds gradually until he can touch the animal with the hand.

When the steer has become approachable a ring is placed in its nose. Soon after it is placed between two trained work steers and the trio are made to pull a heavy disk plow. The middle steer soon learns that it is easier to follow than to buck. It adapts itself to the work after it has had sufficient practice. The next step is to put the steer on the side. Two such steers are often placed on each side of a trained one in the disk plow. In a short time they can be worked by themselves.

The Tuason Brothers in their training start differently. Within a few days after ringing, the steers are taken to the field where trained steers are working on a disk plow drawn by three animals. One new steer is secured by means of short rope tied to the horn of the trained steer on either side of the trio. Very soon two such steers can be tied on each side of the trio. During the first few days these amateur work steers simply follow the old ones. The rest of the process is similar to that used by Cruz. The Tuason Brothers have broken by this method as many as thirty steers during one season.

Dr. Ralph Gearhart's plan seems even more practical. He has the amateur steer secured in a yoke between two trained steers and the trio turned loose for about fifteen days in a near by pasture. They are then caught and hitched to a disk plow.

The method, which for lack of a better name we will call the "Cudal" method, works this way. Young steers of about one and a half years old are given to homesteaders in the neighborhood on the basis of credit sale at eighty pesos each to be paid at end of the year. If the homesteader can not pay for the steer when the time is expired he returns the plow broken steer to its former owner. Under this system as many as eighty steers can be farmed out in one season. The question may be asked: How do the homesteaders break these steers? It is difficult to answer this question as they use a number of different methods, and no one of them has proved entirely successful. The procedure most commonly followed is to tame the animal. This is done by securing him in very strong stanchions usually under a shade tree. The animal remains in a standing position with very little food and water for about three days. When grass and water are offered, the animal is handled gradually. The next step is to ring the animal in the nose and to lead it by a rope. The animals are taught to lead on a rope by two men, one standing in front and the other behind, and both holding a rope fastened to the animal on the horn through the ring. In this position the animal can be pulled without much trouble. The next step is to place a yoke on the animal's neck. Once the animal gets used to the yoke a bamboo pole is attached on each side. At first no weight is placed on these poles, but soon the steers can be made to pull light weights which are gradually increased. In the course of a few months, the steer can be made to pull a harrow. From this stage on it is easy to hitch the steer to a plow instead of the harrow.

In the foregoing discussion only the cases that are easy to train have been described. From information obtained this type constitutes only about fifty to sixty per cent of the steers that are broken. About thirty per cent of them are very nervous in temperament and can be trained only if properly handled. About ten to fifteen per cent of the animals are extremely vicious. Many can be broken only with a great deal of difficulty and at some risk and after much patience. There are a few steers that can never be broken. With nervous animals the ranchers claim that the best thing to do is quiet them down. They find that to excite the animals further with a lot of noise or with the use of a whip only retards the training. The sooner the animals know that they will not be hurt unduly or mistreated the sooner they quiet down and submit to the trainer's wishes. The vicious animals may be divided into two groups; namely, those that are violent, and those that are passively resistant. Fortunately, the greatest majority of the vicious animals belong to the latter class. In this class the animal plants itself securely on the ground and refuses to move. The severest corporal punishment usually has no effect on him. Mr. Cruz has estimated that about seven per cent of all steers that are broken for work meet some kind of accident. Mr. N. Tuason claims to have observed a concrete case of suicide in a high grade Indian steer. The animal refused to get up and remained in this position until it died. It is generally agreed that the extreme cases of viciousness are met in animals having a high percentage of Indian blood.

DISEASES AND PARASITES

At present, with the exception of the foot-and-mouth disease, there are no very serious cattle diseases in Bukidnon. Although the first cases were discovered in the interior of the province, some people claim that the foot-and-mouth disease was introduced into Bukidnon in November, 1925, by infected carabaos which passed through a broken fence near the Alae Quarantine Station. (Pineda, 1926.) Others claim that foot-and-mouth disease broke out in Bukidnon at a much earlier date. The mortality from this disease is not great.

According to Mr. Florentino Cruz, the Indian cattle are resistant to this disease and this characteristic appears to be heritable.[5] It is reported that rinderpest broke out on the Diklom Ranch in 1918 from native cattle that were vaccinated with experimental rinderpest vaccine. A considerable loss resulted before the disease could be controlled. There has been no outbreak of rinderpest since 1918. It was also reported by Pineda (1926) that pure-bred Indian and grade cattle were not affected by this disease.

In the writer's opinion the most serious problem of the cattle industry in Bukidnon today is the tick. This pest is widespread in Bukidnon and affects both cattle and horses. It is generally admitted that ranching cannot be run without horses and some ranchers have been unable to raise colts in certain places because they become so heavily infested with ticks. Weekly application of tick remedies gives only temporary relief, and the colts die without any premonitory symptoms. It is quite possible that the ticks suck so much blood that the animal's vitality suffers and it dies of inanition. Unless something can be done to reduce the number of ticks, if not to eradicate them, in the course of a few years the question in Bukidnon will be: cattle or ticks, which?

It would seem that the pastures could be managed so as to reduce the ticks to the minimum and at the same time improve the pasture grass. Mr. Florentino Cruz has shown that this is practicable. By a system of partial burning of the pasture grass into relatively smaller lots, for the purposes of rotation, Mr. Cruz claims that he has been able to minimize the number of ticks. It has been his experience that when a portion of the pasture that is covered with a good bedding of cogon, *Imperata cylindrica* or of bagocboc, *Andropogon nitidus*, is available the cattle usually prefer to pass the night there. Places where cattle pass the night for a period of about two weeks should be heavily loaded with adult ticks or their eggs. If these places are burned a large number of the pest will be eliminated. Removal of the ticks from the animal's body by dipping at suitable intervals would aid greatly in eradicating them. Experience in other countries, notably in the southern part of the United States, should be of value in this connection. (Anonymous 485-498. 1916.)

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[5] Information gathered by Dr. Valente Villegas in Bukidnon in 1925.

FINANCIAL RETURNS

A discussion on ranching would be lacking with no reference to financial returns. The story of Mr. Florentino Cruz is quite widely known in the Philippines. Starting with practically no capital some thirteen years ago, Mr. Cruz is now worth about one hundred and fifty thousand pesos which for the most part has been made on his ranch. The story of Manuel Fortich is not so well known to the ranchers in the Philippines. Mr. Fortich who was at one time governor of Bukidnon may be called the father of the ranching business in Bukidnon. As he gradually progressed he helped other ranchers to build up their herds. Today, Governor Fortich is probably the richest man in Bukidnon. Mr. Teofilo Alvarez' career as a rancher should be an inspiration to others. He started with four head of cattle in 1914. In 1918 he added twenty-three head to his herd and made a few additions thereafter. In 1921 he sold twenty-three steers at 173 pesos a head. From this sale he states that he recovered all that he had put on the ranch up to that time.

Prospective ranchers should not be led to believe that every cattle man in Bukidnon is successful, for there have been a number of notable failures. The case of Mr. A. may be cited. According to information received this man started in 1915 with 15 breeding females and one male. Mr. A. was a government official at the time, so he left his herd to the care of an *encargado*. To his great disappointment he found that not one cow had dropped a calf in three years. He was glad to sell his herd to Mr. B. in 1918. It was learned later that the only male in the herd was an old steer, hence the failure of reproduction. The case of Mr. C. may be given as another example. This man started with 78 head about two years ago, but left his herd in the care of an *encargado*. When stock was taken in May, 1930, only 68 animals could be located. Many of these were thin and were heavily infested with parasites. These two cases show that the best results in the ranching business can be obtained only when one personally manages his ranch.

The foregoing are extreme cases of success and failure in the ranching business. An intermediate condition is afforded by the Diklom Ranch. The ranch, opened in 1914, was originally a coconut planting corporation. While the coconut trees were under cultivation some cattle were raised on the hillsides. The coconut project failing, the corporation turned to cattle raising. This ranch has been managed not through *encargado* but by ranch superintendents, men who understood their work well. According to Pineda (1926) in September. 1925, there were 8,207 head of cattle on the ranch and in December, 1929, the cattle numbered about 10,000 The operation expenses, total number of cattle, and the annual expenses per head from 1919 are shown in the tabulation below:

The operating expenses, total number of cattle, etc., of the Diklom Ranch, during a period of eleven years (1919–1929)[a]

YEAR	OPERATING EXPENSES	TOTAL NUMBER OF CATTLE	ANNUAL EXPENSES PER HEAD
1919	70,910.84	4,083	₱17.37
1920	57,681.48	4,273	13.50
1921	54,193.13	5,067	10.67
1922	45,991.41	6,050	7.60
1923	37,172.02	7,156	5.20
1924	45,304.26	7,753	5.80
1925	47,274.4	8,583	5.51
1926	50,304.04	7,423	6.78
1927	39,350.40	8,485	4.64
1928	39,199.60	9,936	3.95
1929	54,012.84	9,596	3.63

[a] From the annual report of Mr. N. S. Saleeby, Vice-President and General Manager of the Agusan Coconut Company, to the trustees for the Bukidnon Associates on holdings in the Philippine Islands for the year 1929.

SPECIFIC PROBLEMS

The problem of cattle ranchers in Bukidnon that requires immediate solution is the disposal of their surplus stock. Prior to 1909 practically no cattle could be found in the province. In the Census of the Philippine Islands for 1918, 4,960 head of cattle were reported of which 37.8 per cent were native, 0.3 per cent were Herefords, 14.3 per cent were Indian, and 48.6 per cent were grades. Estimates at the end of 1929 place the cattle population at 46,748, the great majority of which are grades. If these animals continue to reproduce at the same rate they have during the past twelve years, the December, 1929, census will be duplicated in three years. Six years hence there would be over 180,000 head of cattle in Bukidnon. The present number is capable of producing yearly over 8,000 steers which dress on the average about 150 kilograms each, thus making over one million two hundred thousand kilograms of beef.

At present Manila and Negros are the only markets for Bukidnon cattle. Steers are sent to Manila for beef and the work animals go to sugar plantations in Negros. Not having an organized system of marketing cattle the ranchers find it difficult to sell a small number of animals. When buyers go to Bukidnon they encounter some difficulties in getting the animals they buy out of the province. Cattle are loaded on ships in the most primitive fashion because there are no loading piers. Many animals die during the process of loading and those that are loaded lose considerable weight during the trip to Manila or Negros. It would seem advisable and to their interest for the ranchers in Bukidnon to organize themselves into a body for the purpose of marketing cattle and constructing a pier provided with facilities for loading cattle properly.

There has been a great diversity of opinion as to the amount of the different kinds of blood that should be incorporated to produce the best animal for the Bukidnon ranchers. Some contend that only the Indian and the Native need be combined. Others believe that the addition of Hereford or some other blood is necessary. Those who take the first view say that the ideal combination is one-half Indian, one-half native, that 75 per cent Indian is tolerable and over that should not be tolerated. They say that animals carrying more than 75 per cent of Indian blood are too wild, have a poor beef conformation, and reproduce very slowly. Those who take the second view have similar arguments for their practice. The only way to settle this question is by experiments carried out in Bukidnon.

The question of pasture management needs some attention. All over Bukidnon the prevailing pasture grasses are cogon and bagocboc. These grasses are good pasture feed and are relished by cattle when young. Heretofore the universal practice of burning pasture constitutes the only system of pasture management in Bukidnon. Some ranchers set extensive areas of pasture on fire at one time, others burn only in small portions at a time. By this burning, rotation of pasture can be practiced without any need of extensive fencing.

There has been a good deal of talk regarding pasture area for Bukidnon ranchers. Some contend that the present limits allowed by law are entirely inadequate. Others believe that legislative action limiting the number of animals to a given area is necessary to protect the live stock industry. It seems to the writer that studies for the purpose of determining the system or systems of managing pastures, with the idea of improving pasture grasses, removing ticks and other parasites, and utilizing all the land that is available for grazing purposes as economically as possible must precede any government interference regarding pasture land laws.

And last, but not least, is the question of quarantine. From the point of view of disease prevention, Bukidnon by its isolation and because of its strategical position has a decided advantage for the strict enforcement of quarantine. It is guarded on the eastern and western sides by very high mountains. On account of great distances, it is not easily accessible from the southern end. Its only inlet and outlet is its northern end at Alae. The present measure instituted by former governor Manuel Fortich is to place a permanent quarantine at Alae. The foot-and-mouth disease was probably introduced into Bukidnon in 1923 through weak enforcement of quarantine at this channel. At present, losses from diseases in Bukidnon are not great. Anthrax and surra have not been reported. No outbreak of rinderpest has occurred since 1918. The cattle industry in Bukidnon must be preserved by enforcement of very rigid quarantine regulations. In this connection the oft repeated but infrequently practiced maxim comes to mind; "an ounce of prevention is worth a pound of cure".

SUMMARY AND RECOMMENDATIONS

1. There is a well developed cattle industry in Bukidnon actually capable of turning out over one million kilograms beef of a year. At the present rate of increase of cattle in Bukidnon this production will be duplicated in the course of three years.
2. A system of marketing cattle that will enable ranchers to sell any number of animals at any time is an immediate need in Bukidnon.
3. The construction of a loading pier would facilitate the shipment of cattle thereby preventing the loss through animal shrinkage in weight and loss of time in loading now experienced under the present method of shipment.
4. A method of managing pastures that will improve the pasture vegetation, eradicate the ticks, and will enable ranchers to utilize all the pasture areas economically should be developed.
5. The cattle industry in Bukidnon must be protected from disease not by the promulgation of new quarantine regulations at Alae but the rigid enforcement of those now existing.

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THE USE OF THE ANTIMONY ELECTRODE IN THE CONTROL OF CANE JUICE DEFECATION AND FOR MEASURING THE HYDROGEN ION CONCENTRATION OF SOILS[1]

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WITH ONE CHART

In the control of liming, three procedures have been proposed. (1) Intermittent liming, that is, where the pH of the juice in the liming tank is recorded bv a pH recorder, the final reaction being obtained after successive limings. (2) Continuous liming operated by man, that is, where the pH of the juice after liming the heaters is recorded by a pH recorder, which indicates to the operator the speed of liming. (3) Continuous and automatic liming where the speed of liming is controlled by the pH recorder. These three methods have been described by Balch and Paine (1925) (1928). These authors, however, used tungsten electrode in the cell, which they and others have found to give "drifting" values of the e. m. f., hence, require frequent checking by other methods of pH determination. The writer proposes to replace this tungsten electrode with the antimony electrode which has been found to give consistent results in the chemistry laboratory of this College. The advantages of the antimony electrode over the other electrodes in use are: (*a*) the ease with which it can be prepared and its cheapness; (*b*) the quick response it gives after immersion in the solution; (*c*) its fairly constant behavior at a given pH; and (*d*) the wide range of pH in which it can be used.

PROPOSED CHEAP METHOD FOR CONTROLLING DEFECATION BY INTERMITTENT LIMING

For intermittent liming, the writer suggests the use of a simple and cheap pH indicator sold by Leeds and Northrup Company, 4901 Stenton Avenue, Philadelphia, Penna., U. S. A. The potentiometer indicator which has a range of 0.1—0.4 volt, when used with the quinhydrone electrode, should have a range of 0.35—0.60 volt to correspond to pH between 5.5 to 9.5 when used with the antimony electrode.

The method of liming used is the intermittent, but instead of using a continuous recorder, a potentiometer indicator is used which must be

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[1] Experiment Station contribution No. 663. Read before the Los Baños Biological Club, June 26, 1930. Received for publication July 1, 1930. This work was undertaken at the suggestion of Associate Professor V. G. Lava.

noted more or less constantly during the process of pumping from the liming tank through the electrode chamber.

The antimony electrode

Various investigators have proposed the use of the antimony electrode for pH determination of certain solutions, and recently, Lava and Hemedes (1928) who found its behavior fairly constant in cane juice, proposed its use in cane juice defecation. They found that at 26°—29°C., the relation $E = 0.052 + 0.075\ pH$ held, where E is the observed e. m. f. of the cell, Sb electrode—solution—normal calomel half-cell. Because of certain errors due to diffusion, and because of the time consumed in the preparation of the normal potassium chloride for use in the normal calomel half-cell, the saturated calomel half-cell (using saturated KCl) should be preferred for use in the control of pH in cane juice defecation.

The antimony electrode in pair with the saturated calomel half-cell was tried on nine different buffer solutions. The temperature of the experiment ranged between 24 to 31°C.; no attempt was made to correct the temperature effects. For this work the antimony electrode was cleaned every 6 hours. The relations $pH = \frac{0.4538 \pm E\ obs}{0.06}$ and $pH = \frac{0.005 + E\ obs}{0.058}$ were used for calculating the pH by the quinhydrone electrode and by the antimony electrode, respectively. E is the observed electromotive force.

Lava and Hemedes (1928) who used the antimony electrode in sugar cane crusher juices obtained consistent results. In lowering the pH value of the juice, a definite amount of one-tenth normal hydrochloric acid was added to beakers containing the juice; and in raising the pH value, a definite amount of ten per cent solution of lime was added to the juice. Each mixture was stirred well and divided into two equal parts. The potential of one part was determined by the antimony electrode, the other part by the quinhydrone electrode according to the technic of Lava and Hemedes (1928) with the use of an agar bridge. The results of the experiment are given in table 3.

The antimony electrode was also tried by Lava and Hemedes (1928) in soils. They obtained results similar to those of Snyder (1928). Different soil solutions prepared in the proportion of one soil to one water by volume were stirred well and allowed to stand for ten minutes. Each soil solution was divided into two equal portions. The potential of one portion was determined by the antimony electrode, the other portion by the quinhydrone electrode. The method used was the same as that for sugar cane juice except that the cell was not shaken. Table 4 shows the results of the experiments. Some of these soils gave a difference greater than 0.2 pH. These soils may contain enough manganese to influence the readings of the quinhydrone electrode. A further study of these soils and a more extensive work on the effect of manganiferous soils in the accuracy of the antimony electrode will be carried out in the near future.

DISCUSSION OF RESULTS

Experience has shown that while the dull electrodes of unknown history may give reproducible values of pH, under certain conditions, more reliable readings are obtained when bright electrodes are used initially. For cleaning the electrodes ordinary sandpaper is all that is necessary.

Table 1 shows the average potentiometer readings corresponding to nine different buffer solutions, when bright electrodes were used. Four different Sb electrodes were used in different samples of the nine solutions, and cleaned before each immersion in a solution. There was no shaking of the solutions. The index number of the solution is given in column 1, table 1; in column 2 the pH as determined by the quinhydrone electrode and by the hydrogen electrode (value in parentheses) is given; in column 3 the electrode number is given; in column 4 the average potentiometer readings, taken within 15 minutes, corresponding to the first sample of each solution used are given; in column 5 records similar to those in column 4 are given except that second samples are used; column 6 gives data similar to that of columns 4 and 5 except that third samples of each solution were used; column 7 shows the average values of the readings from columns 4, 5, and 6. For each solution there is given an average potentiometer reading obtained from the four different electrodes and three different solutions. The probable error of this average is also calculated from the twelve different readings. It may be pointed out that each of the readings shown in columns 4, 5, and 6 is the average of four different readings taken at 1 minute, 5 minutes, 10 minutes, and 15 minutes after immersion of the electrode; the extreme readings at these different times do not generally vary by more than 0.005 volt.

It may be seen in table 1[2] that the probable error of each of the average potentiometer readings for each buffer solution is fairly small for many purposes, and that the average of the maximum deviations between the individual electrode readings is 0.005 volt, as is also the average of the maximum deviations between the individual electrode readings for the same solution. This difference corresponds to a difference in pH of about 0.08, so that it would appear that this would be the average error in pH involved with the use of the antimony electrodes and the present set-up.

Chart 1 shows the relation between pH and potentiometer readings of the cell, Sb-solution-saturated calomel half-cell. The equation corresponding to this relation has been found by means of least squares to be:

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[2] It has been found that some buffer solutions, such as the citrates-NaOH mixtures, do not give pH values as calculated from the formula $pH = \frac{0.005+E\ obs}{0.058}$ which agree with pH values obtained by means of the quinhydrone electrode.

$E = 0.058\ pH - 0.005$ where E = potentiometer reading of a solution of definite pH.

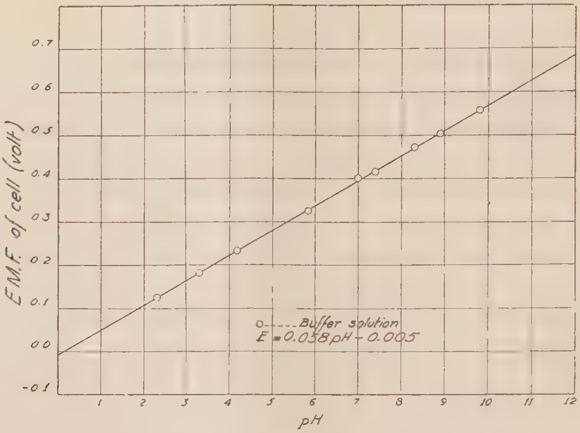

Chart 1.—Showing the relation between pH and potentiometer readings of the cell, Sb-solution-saturated calomel half-cell.

To show the effect of previous immersions in solutions of different pH upon the electrodes, the following experiment was carried out: Four different electrodes were cleaned bright and immersed in different solutions for a period of 25 minutes each, four potentiometer readings for each electrode being taken during each immersion and the average found. Before each immersion the electrodes were rinsed with distilled water. Table 2 shows the results of this experiment. Column 1 gives the solution in which the electrodes were previously immersed, the previous time of immersion being indicated in parentheses; column 2 gives the solution in which the electrodes were actually immersed for purposes of potentiometer readings; column 3 gives the average reading actually found for each solution in column 2; column 4 gives the value of the potentiometer reading which should be obtained if the electrodes were cleaned; column 5 shows the extent of the variation of the readings from the theoretical values (that is, when clean electrodes were used).

It may be seen that if the clean electrodes are immersed consecutively in different solutions during a total period of two hours, the potentiometer readings obtained vary from the true readings for these solutions by an average of 0.004 volt, which is within the limit of error. If, however, the electrodes have been used for a long period of time as evidenced by a dark coating on the surface, the average differences between the potentiometer reading and the true reading is 0.008 volt. Furthermore, it may be seen from table 2 that in some cases the variation is as much as 0.014 volt, equivalent to about 0.3 pH.

SUMMARY

1. A method of intermittent liming is proposed which requires the use of only a pH indicator. This pH indicator is much cheaper than a potentiometer recorder.

2. In the construction of the electrode cell used in all procedures, instead of the tungsten electrode, the adoption of the antimony electrode in pair with the saturated calomel half-cell is proposed for use in the control of pH in cane juice defecation and for measuring the hydrogen ion concentration of soils. This electrode has the advantage of cheapness, strength, ease with which it can be cleaned, quick response to reaction, and behavior not affected during at least 3.5 hours of continuous immersion in different solutions.

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TABLE 1

Average readings within 15 minutes (bright electrodes)

I	II	III	IV	V	VI	VII
Solution used	pH	Electrode No.	Solution Sample 1	Solution Sample 2	Solution Sample 3	Average
			volt	*volt*	*volt*	*volt*
7 Borate and NaOH	9.75 (9.77)	1	0.561	0.560	0.557	0.559
		2	0.563	0.567	0.558	0.563
		3	0.563	0.562	0.557	0.561
		4	0.563	0.564	0.560	0.562
		Average	0.563	0.563	0.558	
				General	Average	0.561±0.0006
6 Borate	8.99 (8.93)	1	0.513	0.510	0.513	0.512
		2	0.516	0.510	0.514	0.513
		3	0.514	0.508	0.511	0.511
		4	0.517	0.508	0.511	0.512
		Average	0.515	0.509	0.512	
				General	Average	0.512±0.0006
5 Borate and HCl	8.32 (8.27)	1	0.475	0.471	0.463	0.470
		2	0.474	0.474	0.465	0.471
		3	0.471	0.473	0.464	0.469
		4	0.472	0.471	0.465	0.469
		Average	0.473	0.472	0.464	
				General	Average	0.470±0.0008
4 Borate and HCl	7.43	1	0.424	0.423	0.418	0.422
		2	0.426	0.422	0.421	0.423
		3	0.423	0.423	0.418	0.421
		4	0.425	0.423	0.422	0.423
		Average	0.425	0.423	0.420	—
				General	Average	0.422±0.0005
A M/5 KCl M/5 HCl	2.28	1	0.124	0.127	0.132	0.128
		2	0.125	0.131	0.129	0.129
		3	0.122	0.129	0.124	0.125
		4	0.123	0.128	0.127	0.126
		Average	0.123	0.129	0.128	
				General	Average	0.127±0.0006
B M/5 KH Phthalate M/5 HCl	3.26	1	0.177	0.181	0.179	0.179
		2	0.178	0.181	0.178	0.179
		3	0.176	0.180	0.177	0.178
		4	0.176	0.180	0.177	0.178
		Average	0.177	0.180	0.178	
				General	Average	0.178±0.0004
C M/5 KH Phthalate M/5 NaOH	4.10	1	0.241	0.236		0.238
		2	0.233	0.233		0.233
		3	0.234	0.231		0.232
		4	0.233	0.235		0.234
		Average	0.235	0.234		0.234
				General	Average	0.234±0.0008
D M/5 KH Phthalate M/5 NaOH	5.86	1	0.343	0.340		0.342
		2	0.343	0.341		0.342
		3	0.342	0.339		0.340
		4	0.343	0.339		0.341
		Average	0.343	0.340		0.341
				General	Average	0.341±0.0007
E M/5 KH_2PO_4 M/5 NaOH	6.97	1	0.413	0.412	0.404	0.410
		2	0.412	0.424	0.403	0.413
		3	0.413	0.416	0.403	0.415
		4	0.412	0.415	0.401	0.409
		Average	0.412	0.417	0.403	
				General	Average	0.412±0.0013

TABLE 2

Showing effects of previous immersion in different solutions upon electrode readings

I	II	III	IV	V
Solution where electrodes were previously immersed	Solutions where electrodes were immersed for potentiometer readings	Average potentiometer reading for the four electrodes	True readings, using bright electrodes	Difference between actual readings and true readings
C (25″) M/5 Khphthalate, M/5 NaOH......	A	0.131	0.127	0.004
A (25″) M/5 KCl, M/5 HCl................	C	0.241	0.234	0.007
C (25″) M/5 Khphthalate, M/5 NaOH......	D	0.345	0.341	0.004
D (25″) M/5 Khphthalate, M/5 NaOH......	E	0.405	0.412	0.007
E (25″) M/5 KH_2PO_4, M/5 NaOH.........	B	0.178	0.178	0.000
			Average	0.004
Previously immersed in many different solutions and allowed to stand in air for three days..................................	A	0.129	0.127	0.002
A (25″) M/5 KCl, M/5 HCl................	B	0.175	0.178	0.003
C (25″) M/5 Khphthalate, M/5 NaOH......	D	0.335	0.341	0.006
D (25″) M/5 Khphthalate, M/5 NaOH......	E	0.401	0.412	0.011
4 (25″) Borate and HCl....................	5	0.461	0.470	0.009
5 (25″) exposed to air over-night Borate and HCl....................................	7	0.572	0.561	0.011
7 (25″) Borate and HaOH..................	6	0.526	0.512	0.014
4 (25″) Borate and HCl....................	5	0.470	0.470	0.000
5 (25″) Borate and HCl....................	6	0.517	0.512	0.005
6 (25″) Borate...........................	7	0.566	0.561	0.005
7 (25″) Borate and NaOH..................	A	0.136	0.127	0.009
A (25″) immersed in water, over-night M/5 KCl, M/5 HCl..........................	A	0.113	0.127	0.014
A (25″) M/5 KCl, M/5 HCl................	B	0.168	0.178	0.010
			Average	0.008

TABLE 3

Agreement between the pH value obtained by the quinhydrone electrode and antimony electrode using crusher juice at 24°—31° C.

D[a] VESSEL SHAKEN	S[b] VESSEL NOT SHAKEN	S − D
pH	*pH*	*pH*
4.51	4.60	+ 0.09
3.94	4.00	+ 0.06
6.30	6.20	− 0.10
6.93	6.80	− 0.13
6.57	6.50	− 0.07
5.41	5.40	− 0.01
6.30	6.30	− 0.00
7.10	7.20	+ 0.10
6.50	6.60	+ 0.10
5.20	5.30	+ 0.10
7.60	7.50	− 0.10
9.03	9.40	+ 0.37
8.00	8.10	+ 0.10
8.00	8.00	− 0.00
9.70	9.40	− 0.30
5.60	5.52	− 0.08
2.30	2.36	+ 0.06
6.90	6.98	+ 0.08
6.71	6.73	+ 0.02
3.96	3.97	+ 0.01
4.29	4.19	− 0.10

[a] D, represents pH obtained by the clean antimony electrode.

[b] S, represents pH obtained by the quinhydrone electrode.

TABLE 4

Agreement between the pH obtained by quinhydrone electrode and antimony electrode using soil solutions prepared in the ratio of one soil to one water by volume at 24°—31°C.

SOIL INDEX	D[a] VESSEL NOT SHAKEN	S[b] VESSEL NOT SHAKEN	S – D
	pH	*pH*	*pH*
1-A	6.3	6.4	+0.1
2	6.6	6.6	+0.0
2 (0–100)	6.4	6.4	+0.0
4S[c]	6.6	6.9	+0.3
8	7.5	7.6	+0.1
9A	7.1	7.0	–0.1
7[c]	7.6	7.9	+0.3
10[c]	7.4	7.7	+0.3
11[c]	7.3	7.6	+0.3
12	7.1	7.1	+0.0
9B	7.9	8.1	+0.2
13A	7.0	7.0	+0.0
13B	7.4	7.5	+0.1
14A	7.1	7.1	+0.0
14B	7.2	7.4	+0.2
15A	7.1	7.3	+0.2
15B	7.4	7.5	+0.1
Pamp. 87	5.6	5.5	+0.1
Pamp. 99[c]	5.8	5.5	–0.3
D3c	4.8	4.5	–0.3
41A[c]	7.0	7.4	+0.4
8-T	5.5	5.4	–0.1
I2	6.7	6.7	+0.0
J1	6.5	6.4	–0.1
5[c]	8.0	8.4 (6.8)[d]	+0.4
6[c]	6.9	7.9 (6.8)[d]	+1.0
4R[c]	7.3	7.7 (6.9)[d]	+0.4
P2[c]	5.2	4.8 (6.0)[d]	–0.4
P3[c]	5.4	4.8 (5.4)[d]	–0.6
P1[c]	5.4	4.8 (5.6)[d]	–0.6
J2[c]	6.4	6.0 (6.0)[d]	–0.4
4ST2[c]	6.7	7.6 (6.0)[d]	+0.9
Pamp. 245[c]	6.4	7.9 (6.2)[d]	+1.5
299[c]	6.8	8.1 (6.6)[d]	+1.3
F2[c]	7.5	8.1 (7.2)[d]	+0.6
E2[c]	7.2	7.8 (7.2)[d]	+0.6
E1[c]	6.6	7.4 (6.5)[d]	+0.8
H2[c]	6.3	6.8 (6.0)[d]	+0.5
G1[c]	6.4	7.7 (6.4)[d]	+1.3
G2[c]	7.4	8.1 (7.0)[d]	+0.7
Pamp. 154[c]	6.3	6.0	–0.3
Pamp. 130	6.1	6.2	+0.1
Pamp. 137	5.9	5.8	–0.1
Pamp. 281	5.9	6.0	+0.1
F1[c]	7.0	7.3	+0.3
H1[c]	6.5	6.8	+0.3
D1[c]	5.4	5.1	–0.3
D2	5.4	5.3	–0.1
I1	6.8	6.9	+0.1
42S[c]	7.0	7.6	+0.6

[a] D represents pH obtained by the clean antimony electrode.

[b] S represents pH obtained by the quinhydrone electrode.

[c] These soils may contain enough manganese to influence the readings of the quinhydrone electrode.

[d] Numbers in parentheses are pH obtained by the color method.

FORAGE, WATER, AND SALT CONSUMPTION OF NATIVE CARABAOS[1]

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This work was conducted with the following objects in view: First, to determine the consumption of forage, water, and salt by native carabaos; and, second, to find out the ratio between the amount of forage and water consumed and the weight of the animals.

This investigation was carried on at the College of Agriculture, Los Baños, Laguna, from January 25 to March 21, 1930, covering a period of 56 days.

CARABAOS

Table 1 records data on the five native carabaos which were used in this experiment. With the exception of one steer, No. 30, all the animals were females, ranging in age from five to twenty years. The smallest animal had an average weekly weight of 449 kgm., and the largest an average of 511 kgm.

BARN

Feeding was done in a barn which had concrete floors and mangers, making it possible to keep the premises sanitary. The animals were kept in individual stalls provided with wooden partitions and stanchions.

FORAGE, WATER, AND SALT

Sugar cane tops, consisting of leaves and the softer ends of cane stalks, gathered fresh each day were used throughout the feeding period. For a few days, when there was a halt in harvesting sugar cane, fresh corn forage was used instead. For purposes of this work, both forages were sufficiently palatable that a maximum amount of them was eaten by the animals at each feeding time.

Ordinary tap water was used in determining water consumption.

The granulated form of common salt was furnished the animals.

MANAGEMENT OF ANIMALS

At 6:00 o'clock in the morning the animals were taken from the paddock. Not every day but frequently, they were washed for cleanliness and also to refresh them. About 7:00 a. m. the animals were placed in their respective stalls and feeding was started. At about the same time

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[1] Experiment Station contribution No. 664. Received for publication, May 15, 1930.

watering and salting were done. The second feeding and watering were at 11:00 a. m. The salt cans were removed at 1:00 p. m. The last feeding and watering of the day were at 4:00 p. m. At 7:00 p. m. the animals were taken from the barn and placed in a paddock for the night. In all cases, each day all the forage, water, and salt they would freely consume were put before the animals.

Consumption of forage, water, and salt was determined by taking the record of the amount placed before the animals and of that left by them. The difference between these amounts represents the quantity consumed.

DISCUSSION OF RESULTS

Forage consumption

As may be noted in the daily record of forage consumption in table 2, the range in the quantity eaten by one animal in one day was from 18.1 kgm. in case of animal No. 4 to 47.6 kgm. in the case of carabao No. 4. Taking all the carabaos together the average amount eaten daily by one was 33.8 kgm.

Ratio between forage consumption and weight of animal

As may be seen in table 5, the ratio between the average daily forage consumption and the average weekly weight of the carabaos was consistently 1 to 0.07 in all cases. That is, for every 100 kgm. of live weight of the animal there was an average forage consumption of 7 kgm.

Water consumption

Table 3 shows the daily amount of water consumed by carabaos. It may be observed that carabao No. 30 drank the minimum quantity, 5.9 kgm. and No. 1 the maximum, 44.5 kgm. The average amount of water a head drunk daily was 25.5 kgm.

Ratio between water consumption and weight of animal

Referring to table 5, it may be seen that the ratio between the average daily water consumption by the carabaos and their weight varied from 1: 0.04 in the case of carabao No. 9 to 1: 0.07 with carabao No. 1, the average ratio being 1: 0.05. Therefore, on an average for every 100 kgm. of the live weight of carabaos, 5 kgm. of water was consumed.

Salt consumption

Table 4 presents the daily salt consumption by the carabaos. There were days when none of the animals would lick salt. Carabao No. 9 did not take any salt for nine days, this being the shortest period that any of them went without this mineral. The longest period, eleven days, of declining salt was with carabao No. 39. The minimum consumption, 0.05 kgm. was by carabao No. 9; the maximum, 1.48 kgm. was taken by animal No. 30. The average daily consumption a head was 0.37 kgm.

SUMMARY

The significant results obtained from this investigation are as follows:

1. That the range in the amount of forage eaten daily by native carabaos was from 18.1 to 47.6 kgm. The average daily consumption was 33.8 kgm.

2. In regard to water consumption, the minimum amount drunk by any animal daily was 5.9 kgm.; the maximum amount was 44.5 kgm. The average daily consumption a head was 25.5 kgm.

3. Salt consumption varied from 0.05 to 1.48 kgm. daily. There were days when none of the animals would lick salt. The average daily consumption a head was 0.37 kgm.

4. A ratio of 1: 0.07 existed between the daily forage consumption and weight of the animals. This means that for every 100 kgm. of the live weight of the animal an average of 7 kgm. of forage was consumed.

5. The proportion of water consumed and the weight of the animals was 1: 0.05. Therefore, for every 100 kgm. of the live weight of the animals the amount of water taken was 5 kgm.

TABLE 1

Showing the sex, breeding, age, and weight of experimental carabaos

ANIMALS	SEX	BREEDING	AGE	AVERAGE WEEKLY WEIGHT
			year	*kgm.*
Herd No.				
1	Female	Native	20	449
4	Female	Native	19	472
9	Female	Native	13	511
30	Steer	Native	7	499
39	Female	Native	5	499

TABLE 2

Showing the daily forage consumption of carabaos

DATE		H. NO. 1	H. NO. 4	H. NO. 9	H. NO. 30	H. NO. 39
1930		*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*
Jan.	30	31.3	33.1	38.6	40.8	40.8
	31	35.8	32.2	46.3	45.4	44.0
Feb.	1	29.0	36.3	35.4	45.4	37.2
	2	32.7	31.8	38.1	39.5	34.5
	3	41.3	46.7	41.3	39.5	41.3
	4	31.3	37.7	35.4	32.2	33.1
	5	31.8	38.1	41.7	45.4	43.1
	6	38.6	40.8	40.8	47.6	42.6
	7	37.2	36.7	39.5	39.0	42.6
	8	33.1	28.1	38.1	44.5	32.2
	9	35.4	34.0	41.3	37.2	40.4
	10	36.3	20.4	36.3	38.6	39.5
	11	31.8	27.7	31.3	34.0	37.2
	12	32.7	28.6	33.6	39.5	31.3
	13	34.5	37.2	46.7	29.5	44.0
	14	41.3	39.0	34.5	44.5	34.5
	15	33.6	36.7	34.5	39.0	42.2
	16	30.8	34.5	31.8	35.4	34.0
	17	31.8	33.6	30.4	41.7	37.7
	18	39.5	40.4	36.3	41.7	37.7
	19	34.5	26.3	33.6	36.3	38.1
	20	31.8	38.6	25.0	35.8	32.7
	21	26.8	24.5	34.9	31.8	32.7
	22	29.9	33.1	28.6	29.5	35.8
	23	31.3	31.3	30.8	32.2	34.5
	24	32.7	30.4	35.8	43.5	33.6
	25	29.9	32.7	32.2	31.8	33.1
	26	36.3	41.3	35.8	47.2	36.3
	27	38.1	38.1	37.2	39.5	36.7
	28	33.1	38.1	32.7	41.3	35.8
March	1	34.0	31.2	34.9	33.6	33.1
	2	31.8	33.6	33.1	33.6	32.7
	3	24.0	22.2	27.7	26.3	34.0
	4	35.4	25.9	41.3	36.7	41.7
	5	28.1	29.0	37.7	29.0	35.4
	6	32.2	32.2	32.2	38.6	32.2
	7	36.7	39.5	34.5	38.6	38.6
	8	27.7	28.6	29.9	36.7	31.8
	9	31.3	28.6	31.3	38.6	41.7
	10	32.2	30.4	31.8	36.7	33.1
	11	27.2	32.2	31.3	34.0	37.2
	12	29.0	26.8	28.1	30.8	31.8
	13	30.8	21.3	26.3	29.5	36.3
	14	31.3	33.6	30.4	27.7	30.8
	15	32.8	18.1	25.0	26.8	25.4
	16	28.6	27.2	28.6	30.8	29.5
	17	24.0	26.8	26.8	28.6	24.0
	18	25.0	34.5	31.8	32.7	24.5
	19	28.6	27.2	28.1	31.8	25.9
	20	22.7	24.0	21.8	29.0	26.8
	21	21.3	25.4	28.6	30.8	27.2
Average		31.9	31.9	33.7	36.3	35.2
General average						33.8 kgm.

TABLE 3

Showing the daily water consumption of the carabaos

DATE	H. NO. 1	H. NO. 4	H. NO. 9	H. NO. 30	H. NO. 39
1930	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*
Jan. 30	20.4	20.0	10.9	22.7	18.1
31	15.4	10.9	8.6	25.9	17.7
Feb. 1	23.1	23.6	15.9	26.3	41.3
2	36.7	32.2	21.3	28.6	32.7
3	23.6	20.4	13.6	35.8	27.7
4	35.4	28.1	20.4	21.8	36.3
5	33.1	32.2	24.5	36.3	28.6
6	34.5	24.5	27.2	27.2	33.6
7	37.2	26.3	19.6	26.3	32.2
8	25.0	27.7	25.4	20.0	23.6
9	28.1	34.5	30.8	32.2	33.6
10	35.4	36.3	37.2	37.7	32.7
11	32.7	16.3	14.1	22.7	36.7
12	38.6	33.1	22.7	30.4	32.2
13	25.0	22.7	25.0	17.7	34.9
14	34.0	32.2	21.8	26.8	25.9
15	36.7	37.2	27.2	24.5	28.6
16	32.7	26.3	24.0	30.4	29.0
17	25.4	22.2	20.9	13.6	21.3
18	34.5	28.1	23.1	28.6	34.5
19	34.5	27.7	18.6	21.8	30.8
20	33.1	25.0	25.9	24.0	26.8
21	27.7	25.9	19.1	23.6	23.6
22	33.6	25.9	25.4	22.2	29.0
23	24.0	23.6	18.1	5.9	24.0
24	19.5	31.8	18.6	23.1	26.3
25	26.3	21.3	25.9	27.2	25.0
26	40.8	25.4	23.6	21.3	21.3
27	18.2	15.4	18.6	27.7	15.4
28	38.6	38.6	24.5	25.9	26.8
March 1	31.3	14.1	31.3	28.1	17.7
2	33.1	30.4	26.3	35.4	22.7
3	35.4	30.8	24.0	27.7	30.4
4	33.6	30.4	20.9	25.4	28.6
5	34.0	28.6	26.3	29.5	27.2
6	25.9	20.9	24.5	14.1	21.8
7	26.8	23.1	21.3	15.9	23.1
8	37.2	30.4	27.2	29.5	29.5
9	29.0	30.4	32.2	25.9	29.9
10	17.2	24.5	12.7	9.5	9 1
11	11.3	16.3	15.0	15.4	14.5
12	25.0	21.8	18.1	19.1	24.0
13	11.3	20.4	13.2	19.1	22.7
14	36.3	15.4	20.4	21.8	29.5
15	35.4	26.3	27.2	23.1	31.8
16	19.5	18.1	15.4	18.1	20.9
17	22.2	18.1	20.4	20.4	21.8
18	22.7	21.8	27.7	26.8	28.1
19	44.5	9.5	21.3	14.5	16.3
20	41.3	24.0	21.3	25.9	27.2
21	43.1	25.9	19.5	36.3	34.5
Average	29.8	25.0	21.9	24.3	26.7

General average .... 25.5 kgm.

TABLE 4

Showing the daily salt consumption of the carabaos

Date		H. No. 1	H. No. 4	H. No. 9	H. No. 30	H. No. 39
	1930	kgm.	kgm.	kgm.	kgm.	kgm.
Jan.	30	0.45	0.45	0.23	1.48	0.23
	31	0.00	0.23	0.23	0.45	0.00
Feb.	1	0.45	0.68	0.68	0.23	0.68
	2	0.45	0.68	0.45	0.23	0.68
	3	0.45	0.23	0.00	0.45	0.68
	4	0.68	0.45	0.68	0.68	spoiled
	5	1.36	1.36	0.45	0.90	1.13
	6	0.45	0.45	0.23	0.45	0.23
	7	0.00	0.45	0.00	0.23	0.23
	8	0.00	0.00	0.23	0.23	0.23
	9	0.23	0.45	0.45	0.45	0.45
	10	0.23	0.45	0.23	0.23	0.09
	11	0.23	0.91	0.68	0.23	0.45
	12	0.23	0.00	0.68	0.23	0.23
	13	0.45	0.23	0.23	0.45	0.91
	14	0.91	0.91	0.90	0.68	0.45
	15	0.23	0.00	0.00	0.23	0.23
	16	0.23	0.18	0.23	0.45	0.45
	17	0.23	0.23	0.23	0.00	0.23
	18	0.45	0.45	0.45	0.45	0.91
	19	0.68	0.45	0.45	0.00	0.23
	20	0.45	0.91	0.45	0.45	0.91
	21	0.00	0.00	0.00	0.23	0.23
	22	0.23	0.00	0.23	0.00	0.00
	23	0.68	0.68	0.00	0.00	0.00
	24	0.23	spoiled	0.23	0.45	0.00
	25	0.68	0.23	0.68	0.68	0.91
	26	0.91	0.23	0.68	0.23	0.23
	27	0.68	0.00	0.00	0.68	0.00
	28	0.23	0.45	0.23	0.45	1.13
March	1	0.68	0.23	0.23	0.00	0.00
	2	0.91	0.68	0.23	0.90	0.91
	3	0.23	0.23	0.23	0.90	0.45
	4	0.23	0.23	0.23	0.45	0.23
	5	0.00	0.91	0.23	0.00	0.23
	6	0.68	0.00	0.00	0.00	0.00
	7	0.68	0.00	0.14	0.23	0.00
	8	0.00	0.45	0.09	spoiled	0.68
	9	0.45	0.68	0.68	0.68	0.45
	10	0.23	0.23	0.00	0.23	0.00
	11	0.45	0.23	0.05	0.00	0.23
	12	0.00	0.45	0.00	0.00	0.00
	13	0.23	0.23	0.68	0.90	0.45
	14	0.00	0.45	0.23	0.68	0.23
	15	0.45	0.45	0.68	0.68	0.91
	16	0.45	0.00	0.00	0.23	0.23
	17	0.45	0.00	0.23	0.45	0.00
	18	0.23	0.23	0.45	0.23	0.45
	19	0.23	0.23	0.23	0.23	0.23
	20	0.23	0.45	1.36	0.23	0.45
	21	0.23	0.23	0.23	0.45	0.45
Average		0.38	0.37	0.32	0.39	0.37

General average..0.37 kgm.

TABLE 5

Showing the ratio between the weight of carabao and the consumption of forage and water

ANIMALS	RATIO BETWEEN WEIGHT OF CARABAO AND FORAGE CONSUMPTION	RATIO BETWEEN WEIGHT OF CARABAO AND WATER CONSUMPTION
Herd No.	1:	1:
1	.07	.07
4	.07	.05
9	.07	.04
30	.07	.05
39	.07	.05
Average	.07	.05

THE NORMAL TEMPERATURE, PULSE, AND RESPIRATION RATES OF PHILIPPINE HORSES[1]

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In the diagnosis and prognosis of numerous diseases of horses and other animals, the body temperature, and the pulse and respiration rates are principal aids to the veterinary clinician. As no study has heretofore been conducted along these lines on Philippine horses, there are no records for clinical reference for the veterinarian in the Philippines, except data obtained in Europe and America. Inasmuch as the horse in both Europe and America is larger than the Philippine horse and lives under quite different conditions, the veterinarian in the Islands, who handles usually only native horses, obviously is at a disadvantage with only standards obtained from the data on foreign horses in foreign lands.

The present study was undertaken to determine the body temperature, pulse, and respiration rates normal for the Philippine horse.

This investigation was begun in March, 1929 and extended to the early part of January, 1930. The observations were made on healthy horses brought to the College of Veterinary Science; on some horses in the Animal Husbandry Department of the College of Agriculture; and on some horses in San Antonio, Los Baños, Laguna and Tanauan, Batangas.

ANIMALS

There were 105 horses used in this study. These animals were apparently healthy; that is, they were free from diseased conditions as far as could be observed externally. Both sexes were included, 43 females and 62 males. They ranged in age from 2-½ to 16 years. Their height varied from 46 to 53 inches. Most of the animals were carromata horses and the others were kept either for riding or for occasional work. During the progress of this investigation the horses were given their usual daily ration, and subjected to no special care or attention.

TECHNIQUE

Observations were made twice daily for five successive days on the first thirty horses, and for three successive days on the remaining seventy-five. From one to five animals were observed at a time. The records for each horse were taken once between six and eight o'clock in the morning,

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[1] Experiment Station contribution No. 665 Read before the Los Baños Biological Club, February 27, 1930. Received for publication May 28, 1930.

and once between four and six o'clock in the afternoon when the animal was at rest or at least not under any strain or excitement. When the animal had been worked or exercised the records were taken after a rest of at least one and one-half hours.

Taking the temperature. The temperatures recorded in this report are all rectal. They were taken with the aid of a German-made veterinary clinical thermometer graduated in degrees and tenths of a degree Centigrade. After shaking down the column of mercury, the instrument was gently inserted almost full length into the rectum, and allowed to remain there for at least four or five minutes. Malkmus (1920) considers this a sufficient length of time for taking the temperature of the animal. The reading was recorded immediately after the thermometer was removed from the rectum.

Taking the pulse. The pulse was felt by gently resting the index, middle, and third fingers on the submaxillary artery near the angle of the lower mandible. The expansions of the arterial wall beneath the fingers were counted for one minute. When the counting was interrupted by some movement of the animal, it was discontinued and another count begun. In some nervous or playful animals where taking the pulse from the submaxillary artery was difficult or impossible, auscultation of the heart-beat with the aid of a stethoscope was resorted to. The diaphragm of the apparatus was applied on the left side of the chest of the animal just behind the elbow of the left limb which was advanced slightly forward. The heart-beats were counted for one minute and the total recorded as the pulse rate. It is accepted that the rate of heart-beat corresponds to the pulse rate.

Taking the rate of respiration. The frequency of respiration was determined by counting the rise and fall of the flank of the animal for one minute. This was conveniently and easily accomplished by holding a watch in one hand close to the flank. Each rise and fall of the flank was carefully watched and counted and the time on the watch was observed at the same time. The counting was repeated when it was interfered with by some movement of the animal. In some cases the average of two counts was taken as the record for that particular time of the day.

RESULTS AND DISCUSSIONS

The results obtained in this investigation are recorded in table 1. The temperature, the pulse, and respiration rates given for each animal are the averages of the morning and afternoon records obtained during the period of observation. The average of the average temperatures and rates of pulse and respiration is taken as the normal for Philippine horses.

There are numerous factors which cause the temperature and pulse and respiration to vary within normal limits in animals of the same species, and also in the same individual. Chief among these are age, sex, temperament, prehension of food, size, atmospheric temperature, restlessness, muscular exertion, and the time of the day. While age, sex, temperament, and prehension of food have little influence on body temperature, they cause appreciable variation in the number of heart-beats and of respiration. The number of heart-beats and respiration to the minute, is greatest in young animals, in females, and during prehension of food. In phlegmatic animals it is less than in nervous ones. The respiration and pulse are slower in large animals than in small individuals. During exertion, restlessness and anxiety, the temperature is greater and the pulse and respiration faster than when the animal is at rest. High atmospheric temperatures cause an increase in body temperature and in the number of pulse and respiration. In the morning, these are lower than in the afternoon.

In this study the variation as influenced by size is not marked as the animals observed were about the same size. The influence of sex and age is not very definitely shown owing perhaps to the fact that the animals were not all observed at the same time. On warm days the temperature and the number of pulse and respiration of the animals were much higher than on cooler days.

Table 2 shows the results obtained in this study compared with the pulse and respiration rates and temperature of European and American horses as given by Paton and Orr (1921), Malkmus, Smith (1921), and Udall (1922). It may be seen from this table that the Philippine horse has a pulse rate which ranges from 38 to 50 a minute, and a respiration rate which varies from 20 to 32. According to Paton and Orr and also Smith the pulse rate of horses ranges from 36 to 40 a minute, while according to Malkmus and Udall, it varies from 28 to 40. The two last named authorities give 8 to 16 as the range of the respiration a minute of horses, but according to Smith it is 8 to 10. By using these foreign standards, it is very evident that one will be apt to consider the much higher pulse and respiration rates of our horses as abnormal or pathological while they are, in fact, within physiological limits, hence are normal.

TABLE 2

Comparison of pulse and respiration per minute, and body temperature of the Philippine horse as found in this study with four reports on similar observations in foreign lands

AUTHORS	PULSE	RESPIRATION	TEMPERATURE
Paton and Orr..	36–40	——	——
Malkmus.......	28–40	8–16	37.5°–38.5°C.
Smith..........	36–40	8–10	37.7°–38.0°C.
Udall..........	28–40	8–16	37.5°–38.5°C.
Philippine......	38–50	20–32	37.4°–38.4°C.

These marked differences between the results of the present study and the foreign standards may be attributed chiefly to the much larger size of the European and American horses and to some degree to the influence of climatic conditions and other factors. This statement is supported by the opinion of Malkmus who maintains that the smaller the animal the greater the number of respirations, and that large animals have less frequent pulse than the small ones. It finds support also in the conclusion of Smith who, in discussing the relation between pulse rate and size of the body, asserts that it varies inversely as the height.

The temperature of Philippine horses which ranges from 37.4° to 38.4° C. (av. 37.9°C.) does not differ materially from the foreign standards. According to Smith, Hobday obtained from a large number of observations 37.9°C. as the average temperature of horses. This same authority claims that a temperature of 38.3°C., while compatible with perfect health is quite exceptional. It was the writer's observation during the progress of this work that a temperature of 38.3°C. was frequently observed, and reference to table 1 will show that even higher temperatures than this were recorded. From these data, it is apparent that what Smith considers an exceptional temperature is quite common with healthy horses in the Philippines.

SUMMARY AND CONCLUSIONS

1. A study to determine the normal body temperature, and rates of pulse and respiration of Philippine horses at rest is here reported.
2. The body temperature of the 105 animals observed, which ranged from 37.4° to 38.4°C., does not differ materially from the foreign standards.
3. The pulse and respiration rates of Philippine horses are much higher than the foreign standards. The pulse rate ranges from 38 to 50, and that of respiration varies from 20 to 32 per minute.
4. If foreign standards are applied to Philippine horses, one might regard as pathological or abnormal these rates which are normal.

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TABLE 1

Average rates per minute of pulse and respiration, and body temperature of each horse in forenoon and afternoon

ANIMAL NO.	SEX	AGE	SIZE (HEIGHT)	PULSE		RESPIRATION		TEMPERATURE	
				a. m.	p. m.	a. m.	p. m.	a. m.	p. m.
		years	*inches*					°C.	°C.
1	F	3	48	44	55	18	30	37.5	38.5
2	F	6	50	40	50	18	28	37.6	38.4
3	M	8	53	37	51	24	36	37.5	38.4
4	M	4½	52	39	53	24	35	37.4	38.4
5	M	6	50	31	50	23	35	37.4	38.5
6	M	16	50	33	50	23	36	37.5	38.5
7	M	7	50	33	51	22	36	37.4	38.4
8	F	3	50	35	48	22	34	37.6	38.5
9	F	4	50	36	51	22	36	37.5	38.3
10	F	10	50	35	52	22	35	37.4	38.4
11	F	16	48	42	53	24	35	37.4	38.5
12	M	9	48	42	52	22	35	37.4	38.5
13	M	10	50	42	53	20	34	37.4	38.5
14	M	9	50	42	51	22	33	37.4	38.4
15	M	8	46	42	51	23	35	37.4	38.4
16	M	6	46	35	52	24	36	37.5	38.5
17	M	7	52	36	51	24	35	37.6	38.5
18	F	8	50	42	53	24	34	37.6	38.5
19	M	2½	48	38	55	22	37	37.5	38.5
20	M	2½	50	35	55	22	36	37.5	38.4
21	F	16	48	35	55	22	35	37.4	38.4
22	F	2½	50	38	56	22	35	37.4	38.3
23	F	9	50	35	55	20	35	37.5	38.5
24	M	7	46	35	56	22	37	37.4	38.4
25	F	8	48	35	55	20	35	37.6	38.5
26	F	8	50	36	55	21	35	37.6	38.5
27	F	8	50	35	55	22	35	37.5	38.4
28	F	7	49	38	55	20	36	37.5	38.4
29	F	2½	48	39	56	24	35	37.5	38.4
30	F	3½	48	37	55	24	35	37.4	38.4
31	F	15	50	37	55	22	35	37.4	38.4
32	M	5	50	35	55	22	35	37.4	38.4
33	M	7	46	37	57	20	37	37.5	38.4
34	M	9	48	35	57	22	37	37.3	38.4
35	M	10	49	33	52	21	33	37.3	38.3
36	F	2½	46	36	49	18	28	37.3	38.4
37	M	2½	48	36	49	19	33	37.4	38.5
38	M	3	48	43	53	18	28	37.3	38.4
39	M	6	50	46	55	21	33	37.3	38.4
40	M	7	50	43	53	20	31	37.3	38.4
41	F	6	50	36	51	18	24	37.3	38.4
42	M	3½	48	33	50	22	35	37.5	38.5
43	M	8	50	39	51	17	27	37.3	38.3
44	F	4½	48	43	53	19	32	37.3	38.3
45	F	5½	50	36	43	19	28	37.4	38.5
46	M	5	50	37	43	20	30	37.4	38.3
47	M	4½	50	41	49	19	26	37.3	38.5
48	F	3	48	37	46	20	30	37.3	38.4
49	F	5½	48	34	50	21	25	37.3	38.4
50	F	6	48	36	48	19	26	37.4	38.5
51	M	5	46	38	45	20	28	37.3	38.3
52	M	7	50	35	50	20	30	37.4	38.5
53	M	4½	48	34	49	20	29	37.3	38.4

TABLE 1—(Continued)

Average rates per minute of pulse and respiration, and body temperature of each horse in forenoon and afternoon

ANIMAL NO.	SEX	AGE	SIZE (HEIGHT)	PULSE		RESPIRATION		TEMPERATURE	
				a. m.	p. m.	a. m.	p. m.	a. m.	p. m.
		years	*inches*					°*C.*	°*C.*
54	F	4	48	35	46	22	29	37.3	38.3
55	F	5½	50	42	49	20	28	37.4	38.5
56	M	5½	50	43	50	20	26	37.3	38.4
57	F	6	50	37	45	21	28	37.3	38.4
58	M	6½	50	37	43	20	27	37.4	38.5
59	M	3½	48	39	45	18	28	37.3	38.3
60	M	3	48	40	46	20	28	37.4	38.3
61	M	4	48	38	45	18	28	37.4	38.4
62	F	3	46	43	48	20	29	37.3	38.4
63	F	4½	48	44	50	21	28	37.3	38.3
64	M	7	50	36	48	20	34	37.4	38.5
65	F	8½	48	33	50	20	32	37.4	38.4
66	M	9	48	35	51	20	30	37.3	38.4
67	M	7	48	33	50	18	28	37.4	38.4
68	M	6	50	42	50	21	32	37.4	38.4
69	M	7	50	42	52	20	30	37.3	38.4
70	F	8	48	39	48	20	33	37.3	38.4
71	M	5	46	39	50	22	32	37.3	38.3
72	M	4½	48	39	53	20	30	37.4	38.5
73	M	6½	48	36	49	20	34	37.3	38.3
74	F	3	50	40	51	19	30	37.4	38.3
75	F	5	50	41	50	19	34	37.5	38.5
76	F	7½	50	35	50	21	30	37.4	38.4
77	F	6½	48	35	48	20	30	37.3	38.4
78	M	5½	48	39	51	20	34	37.4	38.5
79	M	5	48	42	50	21	32	37.3	38.5
80	M	5	50	44	50	20	33	37.4	38.3
81	M	5½	50	43	50	21	34	37.3	38.4
82	M	3	46	39	51	22	35	37.4	38.4
83	F	2½	48	41	50	20	32	37.4	38.3
84	M	4	46	41	50	22	36	37.4	38.3
85	M	8	50	36	48	19	32	37.4	38.5
86	F	10	48	38	50	20	30	37.3	38.3
87	F	6	50	39	51	21	34	37.4	38.4
88	M	5½	48	40	50	21	34	37.3	38.3
89	F	4	46	36	49	20	30	37.4	38.4
90	M	11	46	37	49	20	34	37.4	38.4
91	M	2½	46	40	50	21	30	37.4	38.3
92	M	3	48	41	49	22	33	37.4	38.4
93	M	4½	48	41	49	22	32	37.4	38.3
94	M	2½	46	39	49	22	32	37.4	38.5
95	F	9	46	36	50	20	30	37.3	38.4
96	F	8	48	39	49	21	30	37.4	38.4
97	M	5½	48	41	49	20	32	37.3	38.3
98	M	3½	50	40	50	20	32	37.4	38.4
99	M	7	48	43	50	22	30	37.3	38.4
100	M	3	46	42	50	22	32	37.5	38.5
101	F	4½	50	40	50	21	34	37.5	38.5
102	M	5	48	40	50	22	33	37.5	38.4
103	M	8	48	41	51	22	35	37.4	38.4
104	F	9	48	35	49	22	35	37.4	38.5
105	M	11	50	37	50	22	35	37.4	38.4
Average (normal for Philippine horses)........				38	50	20	32	37.4	38.4

DETERMINATION OF THE RATE OF GROWTH OF CANTONESE CAPONS[1]

JOE R. HAYNES

WITH ONE CHART

Because of the fighting habit and restless temperament of roosters and cockerels, their flesh is of fibrous nature, with very little fat. The flesh of a capon contains a greater amount of fat, has a better flavor and the fibers are not so stringy and tough as those of the roosters. The object of caponizing is the production of larger and fatter birds so as to command a better price in the market.

Slocum (1911) reported that the capon, because of its more peaceful disposition, continues to grow and with a more uniform body development to a somewhat greater size than does a cockerel of the same age. For a time the cockerel and the capon make about equal development, but as soon as the reproductive organs of the cockerel begin to develop the capon begins to outstrip him in growth. Also when finishing off, the capon fattens more readily and economically. As they do not interfere with or worry one another, a large flock of capons may be kept together. Coupled with the better growth of the bird is the better price a kilogram that the capon brings.

Lippincott (1927) stated that the removal of the testes from the male, known as caponizing, which has been practiced commercially for centuries, increases the size of the bird by growth and the laying on of fat, and causes the flesh to remain tender as in a young bird, largely through the failure to develop as much connective tissue as is normal in a mature male.

Masibay (1925) observed in his investigation that the best age from all points, to caponize a cockerel is at about four months. It has been shown by Rodriguez (1923) that the greatest increase in weight of Native capons was reached the sixteenth week after the operation.

It was the object of this experiment to determine the rate of growth of Cantonese capons, and thereby ascertain as near as possible, the best time to market them to insure the greatest returns.

The experiment was begun on June 12, 1928, and ended February 19, 1929. It was conducted under the Poultry Division, Department of Animal Husbandry, Los Baños.

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[1] Thesis presented for graduation, 1929, with the degree of Bachelor of Agriculture from the College of Agriculture No. 315; Experiment Station contribution No. 666. Prepared in the Department of Animal Husbandry under the direction of Dr. F. M. Fronda.

MATERIALS AND METHODS

Sixty cockerels about three and one-half months old were divided into two lots of 30 birds each, as follows:

(*a*) Thirty were caponized

(*b*) Thirty were not caponized

On June 15, 1928, the 30 cockerels were caponized and placed in a pen. This lot was designated lot 1, and separated from the uncaponized 30 which were designated lot 2. It may be mentioned at this point that several other cockerels were caponized for practice before attempting to caponize the cockerels for experiment. However, in spite of the care exercised in the operation, a number of slips were formed. These were removed as soon as they were noticed. Both lots received similar treatment from the beginning of the experiment to the end.

The feeds used in both lots were the same. The ration given was equal parts of grain and mash consisting of:

Grain	Corn 1; palay 1.
Mash	Rice bran 4; copra meal 3; corn meal 2; shrimp 1.

Besides these rations both lots had access to grit, an abundant supply of water in bamboo troughs, and a wide range with plenty of green grass.

The cost per kilogram of the different kinds of feeds used was:

Rough rice (palay)	₱0.081
Whole corn	0.081
Rice bran	0.070
Copra meal	0.070
Shrimps	0.210

Twice daily, grain was fed by giving a small amount in the morning and in the afternoon. The grain fed in the afternoon was about twice as much as the grain fed in the morning so the birds would have their crops full when night came. Every morning the home-made bamboo trough self-feeder in each lot was filled with dry mash to which the birds had access. In addition to this, wet mash was given at noon. The object was to have the birds eat the same amount by weight of grain and mash.

The birds were weighed weekly in a spring balance. At the end of every seven days the grain and the mash mixture left in the cans were weighed; by subtracting this weight from the weight of the feeds put in for the week the amount of feeds consumed was found. The purpose of the weekly weighing was to find out how much feed is consumed at different ages of the birds.

Records were kept of the mortality of the birds in each lot.

RESULTS

Table 1 shows the average weights and gains of the capons and cockerels at different periods of the experiment. The average weekly weights of the capons and cockerels are compared graphically in chart 1.

Table 2 shows the comparison of gains of capons and cockerels, and table 3 gives the amounts of total feed consumed. The comparative costs of keeping capons and roosters are given in table 4. The cost of the different feeds used was based upon the value of these feeds as bought by the Animal Husbandry Department during the year 1928. The capons and roosters were valued according to the Poultry Division prices.

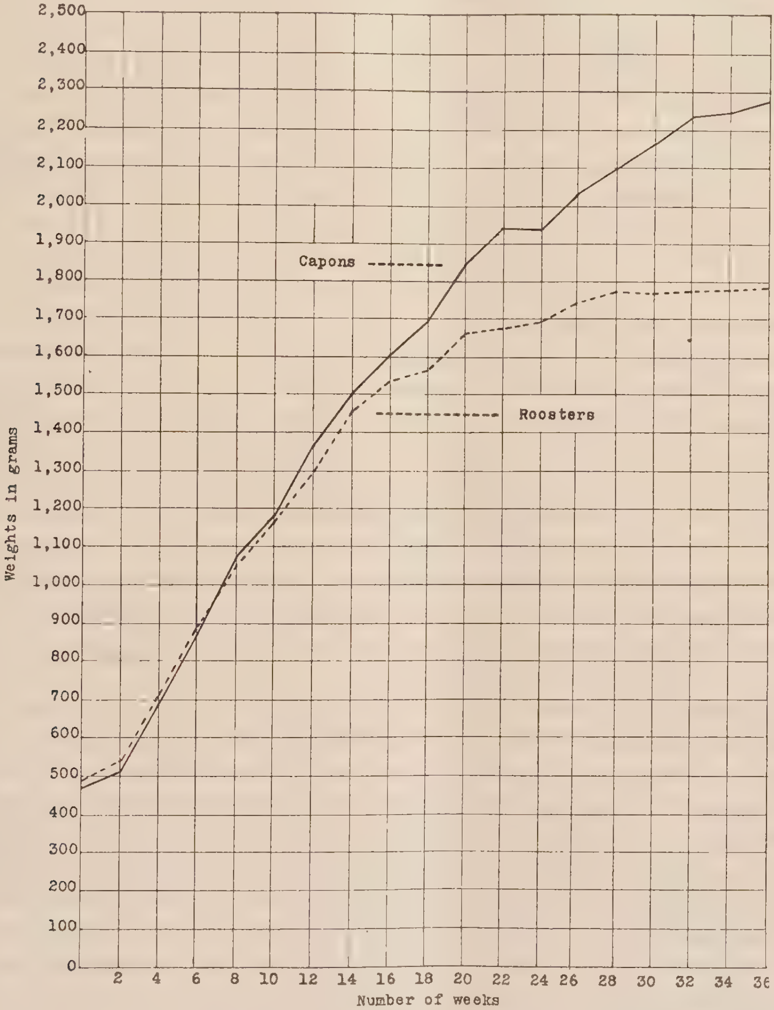

Chart 1.—Showing the average weekly weights of capons and cockerels.

Table 5 presents the percentage of mortality in both lots, and table 6 gives the monthly amount of feeds consumed and the cost of feeds, and gains per 100 birds in each lot.

DISCUSSION OF RESULTS

From table 1 it may be seen that the average weight of the capons four weeks after the operation was 688 grams. The gain in weight during this period was 218 grams. The greatest gain in weight was recorded after the eighth week. But from this period the gain gradually decreased up to the close of the experiment. During the sixth period, November 27, 1928, the decrease was rather abrupt. This abrupt decrease was probably caused by the typhoon which occurred on November 24, 1928. The fowls however, seemed to recover and gain more the following periods, although the general tendency shown was a gradual decrease in the gains. A similar tendency to gradually decrease in gain was shown among the roosters. An abrupt decrease in the rate of gain was recorded for them on November 27, 1928, but although the birds apparently recovered from this, the gain continued to be less until it was practically zero long before the experiment ended.

Rodriguez (1923) found the same result in his investigation on Native capons and roosters. The average weekly growth as shown in the chart reveals the gradual continuous increase in weight of both lots. The greatest gains were recorded during the first two months of the experiment. The differences between the weights of the capons and that of the roosters, however, was not significant during the first three months of the experiment. In other words, both the capons and the roosters gained in weight at the same rate during this period. After the third month of the experiment the difference between the capons and roosters became very significant. It was during this period that the uncaponized lot became sexually mature, consequently they became rather restless and most of the energy received from feed was used up in activity.

Inasmuch as the determination of the growth of the slips was not to be included in the experiment, they were removed as soon as they were discovered. Some of the slips were recognized earlier than others. Eleven of the capons became slips and were noted as follows: one in the second month, eight in the fourth month, and two in the fifth month after the operation. Masibay (1925) reports the growth of the slips in his experiment as being practically the same as that of the capons from the beginning until about five months after the operation. A similar observation was made in the present study, although the data are not included in this report.

Table 2 shows the comparison of gain in weights of the two lots. The total weight of the 18 capons was 40,965 grams. The total weight of the 23 roosters at the close of the experiment was 40,985 grams. From these figures, it can be observed that the average weight per bird in the capon lot was 2,277 grams and in the rooster lot was only 1,782 grams, the capons weighing 495 grams more than the roosters. Calculating on the basis of the initial and final weights of both lots, it can be seen that the capons gained 284.5 per cent and the roosters only 164.4 per cent. It appears then that the capons gained more flesh than the roosters from practically the same amount of feed eaten. The average gains were 1,807 grams per capon and 1,293 grams per rooster with a difference of 514 grams in favor of the capon.

As shown in table 3 the capon lot consumed during the entire experiment 259 kgm. of grain and 245 kgm. of mash. Calculations on 100 capons, show that the total amount feed consumed was 2,193 kgm. consisting of 1,128 kgm. of grain and 1,065 kgm. of mash. The rooster lot for the same period consumed 258 kgm. of grain and 243 kgm. of mash. Basing calculation on 100 birds the feed consumption amounted to only 2,004 kgm., 1,032 kgm. of grain and 972 kgm. of mash. Considering both cases the amount of feed consumed by the capons was greater than that by the cockerel lot. This was because the capons had larger bodies, hence required more feed for growth and for maintaining their body requirements. Since the total weight of the capon lot was 40.96 kgm. and that of the rooster lot was 40.98 kgm., and the actual total feed consumed by the capon lot was 504 kgm. and that by the roosters was 501 kgm. It may be seen that the capons required 12.30 kgm. of feed for every kgm. of weight, and the cockerels required 12.23 kgm.

Table 4 shows the comparative amount and cost of feed eaten by each lot. The total feed consumed by lot 1 was 504 kgm., costing ₱42.13 The rooster lot consumed 501 kgm. of feed costing ₱41.88. Adding the initial cost of the birds used, the total of these two items for the capon lot would be ₱54.12 and for the rooster lot, ₱54.35. The total amount received from the sale of the birds at the close of the study was ₱49.16 for the capons and ₱34.84 for the roosters. With the amount received from the slips that were removed from the first lot, only a margin of ₱9.81 was left in this lot over the initial cost of the birds used and the cost of the feeds consumed. On the other hand, a loss of ₱19.51 was sustained in the rooster lot. Computing on the basis of 100 birds, there will be a margin of ₱54.50 in the capon lot, against a loss of ₱84.83 in the rooster lot. From the financial standpoint these results show that the raising of capons is profitable, while the maintaining of roosters is a losing business.

Regarding mortality, it may be noted in table 5 that in lot 1 only one capon died, but six cockerels died in lot 2. The death of the capon, was caused by poisoning as reported by the Veterinary College. The cockerels died from impaction of the crop. While the difference in the mortality between the capon and rooster lots is significant, the writer can not give any reason for it.

It may be noted that the percentage of slips produced in the capon lot was rather high. This was due to unavoidable breaking of the testes, some of which at the age the cockerels were caponized were too large for the spoon remover to handle. There were 30 birds caponized and 11 of them became slips, giving 36.67 per cent. It is advisable, to prevent so many slips, that Cantonese cockerels be caponized at an age earlier than that of the cockerels used in this work (3-½ months). On the other hand cockerels should not be caponized too young, as Masibay (1925) pointed out in his experiment that there was a high percentage of mortality in lots where cockerels were caponized at the age of about two months.

In table 6, it is shown that in both lots the greatest cost of gain was made when the birds were about 22 weeks old. In this period, also, the feed consumed was about the maximum amount in each lot. Basing calculations upon the relative cost of feed consumed and the cost of the corresponding gains made, it appears that economical gains among capons were made up to the age of 34 weeks or about five months after the operation. Among the roosters, as early as 22 weeks, or about two months after the beginning of the experiment, the amount of gains made were no longer economical. From the thirty-eighth week of age the cost of feed is greater than the value of gain, so that it is a losing proposition to keep the capon after this period.

From the beginning of the experiment up to one month the birds in both lots did not flock together, but individually roamed around the field in search of food. After one month they formed the habit of going together, although in the rooster lot the birds had the habit of fighting each other. The capons were always busy scratching and searching for food while the cockerels depended entirely upon the feed given them. The smaller birds in both lots gained in weight much more slowly than the larger ones. It is recommended that if caponizing is done on an extensive scale, that the birds be classified as to size. In appearance the capons were blocky and with low set bodies, while the cockerels had high set bodies and were bony in appearance. In handling the birds it was found that the capons had rather soft bodies and were tame, while the cockerels had rather hard bony bodies, and kicked badly. The capons continued increasing in weight while the roosters of the same age remained practically stationary. The combs and wattles of the roosters were well developed and dark red, while in the capons they were very small and pale. The saddle and hackle feathers of the capons continued growing and were glossy. The capons had very fine long pointed spurs while the cockerels had short, coarse dull spurs. The cockerels were restless in temperament while the capons clucked and sang like hens. Sometimes a cockerel treated its companions as hens and served them; thus many of the cockerels had the feathers on the back of the head and down the neck pulled out.

SUMMARY AND CONCLUSIONS

1. The greatest gain in weight in both lots was recorded after the eighth week of the experiment.

2. The rate of growth was greater in lot 1 (capons) than in lot 2 (roosters).

3. The difference between the weights gained by each lot during the first three months was not significant but after this period it was decidedly so.

4. To maintain their larger bodies the capons consumed a little more feed than the roosters.

5. For every kilogram of weight the capons needed 12.30 kilograms of feed and the roosters, 12.23 kilograms. This difference is negligible.

6. Lot 1 made a gain ₱9.81 over the initial cost of the birds and the cost of feeds consumed; lot 2, on the other hand, incurred a loss of ₱19.51 for the entire period.

7. Basing opinion upon the results obtained it was profitable to raise capons for marketing.

8. Not only the raising of roosters incurred a loss but the percentage of mortality of the roosters was rather high.

9. To prevent a high percentage of slips it is advisable to caponize Cantonese cockerels earlier than the age of three and one half months.

10. The most economical gains among capons were made at about five months after the operation; the amount of gains after this age was no longer economical.

11. The capons were quiet and peaceful, but the roosters were flighty, restless in temperament, and maintained the fighting habit.

12. The roosters were very fond of crowing. Some of the capons occasionally crowed, or they sang and clucked like hens.

13. On handling the birds it was found that the capons had soft bodies and the roosters had bony muscular bodies.

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TABLE 1

Showing the average weights and gains of capons and roosters

DATE	AGE IN WEEKS	LOT 1 (CAPONS)			LOT 2 (ROOSTERS)			DIFFERENCE BETWEEN CAPONS AND ROOSTERS	CHANGES
		Number of birds	Average weight	Percentage gain	Number of birds	Average weight	Percentage gain		
			grams			*grams*		*grams*	
June 12, 1928.....	14	30	470 ± 77.55	——	30	489 ± 63.10	——	− 19 ± 99.98	Insignificant
July 10, 1928.....	18	30	688 ± 62.06	64.4	29[a]	712 ± 47.25	45.6	− 24 ± 78.00	Insignificant
Aug. 7, 1928.....	22	29[b]	1,074 ± 34.62	56.1	27[c]	1,051 ± 23.13	47.6	+ 23 ± 41.63	Insignificant
Sept. 4, 1928.....	26	29	1,367 ± 13.78	27.3	23[d]	1,297 ± 5.52	23.4	+ 70 ± 14.84	Significant
Oct. 2, 1928.....	30	21[e]	1,609 ± 3.42	17.7	23	1,534 ± 11.32	18.3	+ 75 ± 11.82	Significant
Oct. 30, 1928.....	34	20[f]	1,847 ± 20.34	14.8	23	1,662 ± 19.15	8.3	+185 ± 27.93	Significant
Nov. 27, 1928.....	38	18[g]	1,943 ± 27.16	5.2	23	1,693 ± 22.50	1.9	+250 ± 35.28	Significant
Dec. 25, 1928.....	42	18	2,100 ± 38.33	8.1	23	1,772 ± 28.12	4.7	+328 ± 47.54	Significant
Jan. 22, 1929.....	46	18	2,234 ± 47.86	6.4	23	1,773 ± 28.19	0.6	+461 ± 53.71	Significant
Feb. 19, 1929.....	50	18	2,277 ± 50.91	1.9	23	1,782 ± 28.83	0.5	+495 ± 58.50	Significant

[a] One cockerel died June 25, 1928.

[b] One slip removed July 24, 1928.

[c] One cockerel died on July 13, and one on July 24, 1928.

[d] Three cockerels died, one on August 31, two on September 3, and one was lost on September 4, 1928.

[e] Eight slips removed on September 18, 1928.

[f] One capon died on October 29, 1928.

[g] Two slips removed on November 27, 1928.

TABLE 2

Comparison of gains of capons and roosters

	LOT 1 (CAPONS)	LOT 2 (ROOSTERS)
Total number of birds at the beginning	30	30
Total weight in grams	14,100	14,675
Average weight per bird	470	489
Total number of birds at the end	18	23
Total weight in grams	40,965	40,985
Average weight per bird	2,277	1,782
Average gain per bird	1,807	1,293
Per cent gain per bird	284.5	164.4

TABLE 3

Total feed consumed

	LOT 1 (CAPONS)	LOT 2 (ROOSTERS)
Number of birds at the beginning	30	30
Number of birds at the end	18	23
Actual amount of grain consumed	259 kgm.	258 kgm.
Amount of mash consumed	245 kgm.	243 kgm.
Amount of grain consumed per 100 birds	1,128 kgm.	1,032 kgm.
Amount of mash consumed per 100 birds	1,065 kgm.	972 kgm.
Total feed consumed per 100 birds	2,193 kgm.	2,004 kgm.

TABLE 4

Comparative cost of keeping capons and roosters

	LOT 1 (CAPONS)	LOT 2 (ROOSTERS)
Number of birds	30	30
Cost of the birds at the beginning	₱11.99	₱12.47
Total cost of feed consumed	₱42.13	₱41.88
Cost of birds at end of experiment[a]	₱49.16	₱34.84
Number of slips removed	11	—
Cost of slips removed, 17.38 kgm. at ₱0.85 a kgm. live weight	₱14.77	—
Total income	₱63.93	₱34.84
Income over the initial cost of the birds and the cost of feeds consumed	+₱ 9.81	− ₱19.51
Gain or loss per 100 birds	+₱54.50	− ₱84.83

[a] Capons were sold at ₱1.20, and roosters at ₱0.85 a kilogram live weight.

TABLE 5

Percentage of mortality in both lots treated

	LOT 1 (CAPONS)	LOT 2 (ROOSTERS)
Number of birds at the beginning	30	30
Number of birds that died	1	6
Number of birds lost[a]	0	1
Number of birds removed, as slips	11	—
Number of brids at the end	18	23
Percentage mortality	5.56	26.08

[a] Lost or probably eaten by *musang, Paradoxorus philippenensis* Jourdan. As it was the smallest bird in the flock it did not associate with the larger cockerels.

TABLE 6

Showing the costs of feeds and average gains per 100 birds

DATE	AGE IN WEEKS	LOT 1 (CAPONS)				LOT 2 (ROOSTERS)			
		Feed consumed per 100	Average gain per 100[a]	Cost of feed	Cost of gain	Feed consumed per 100	Average gain per 100[b]	Cost of feed	Cost of gain
		kgm.	*kgm.*	*pesos*	*pesos*	*kgm.*	*kgm.*	*pesos*	*pesos*
June 12, 1928	14	—	—	—	—	—	—	—	—
July 10, 1928	18	175.35	21.8	14.16	26.16	181.44	22.3	15.18	18.96
Aug. 7, 1928	22	194.80	38.6	16.30	26.32	199.44	33.9	16.69	28.82
Sept. 4, 1928	26	287.04	29.3	24.02	35.16	261.30	24.6	21.86	20.91
Oct. 2, 1928	30	318.05	24.2	26.61	29.04	253.66	23.7	21.22	20.15
Oct. 30, 1928	34	266.03	23.8	22.26	28.56	234.26	12.8	19.60	10.88
Nov. 27, 1928	38	280.64	9.6	23.48	11.52	238.78	3.1	19.98	2.64
Dec. 25, 1928	42	275.28	15.7	23.03	17.84	229.26	7.9	19.18	6.72
Jan. 22, 1929	46	285.00	13.4	23.85	16.08	247.22	0.1	20.68	0.09
Feb. 19, 1929	50	274.89	4.3	23.00	5.16	250.78	0.9	20.98	0.77

[a] Capons at ₱1.20 a kilogram live weight.

[b] Roosters at ₱0.85 a kilogram live weight.

NOTE: A FUNGOUS DISEASE OF THE COCONUT LEAF MINER (PROMECOTHECA CUMINGII BALY)[1]

J.M R.

In January, 1930, a dead coconut leaf miner (*Promecotheca cumingii* Baly) was found pasted by a fungous growth on the under surface of a coconut pinna on one of the trees in the College of Agriculture, Los Baños, Laguna. The fungus was isolated in pure culture; and a series of inoculations made in the Department of Plant Pathology gave an average, after six days, of 58 per cent mortality of the inoculated insects. This result shows that the fungus is parasitic on the insects. Every inoculation was done in the afternoon from five to six o'clock by spraying the leaf miners with the spores of the fungus suspended in water.

Infected insects become weak and die usually after three days. The fungous growth, which is pale white and powdery, later appears at the junction of the appendages, at the anal opening, and the mouth parts.

The parasite has been under study for some time and its morphology and cultural characters as well as taxonomic position of the fungus will be more fully studied in this College under the direction of Baker Memorial Professor F. L. Stevens.

Martin S. Celino
Of the Department of Plant Pathology

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[1] Experiment Station contribution No. 667. Received for publication July 31, 1930.

Puns and platitudes from the lips of after-dinner speakers have been barred by the University of Wisconsin Alumni in New York City. At their annual dinner in 1928 the number of speakers was reduced to two; in 1929 it was reduced to one, and the number of alumni attending the dinner doubled. At the banquet held recently there were no speakers, and the attendance increased one-half over 1929. To insure themselves against a break-down in their plans this year, the associaton took out a $100 bond against impromptu speakers. The bond was not forfeited, since each of the 275 persons present held his tongue.

The Review of Reviews, June, 1930.

ABSTRACT[1]

Some factors affecting the growth of alfalfa in the Philippines. SANTIAGO T. MEDRANA. (*Thesis presented for graduation, 1926, from the College of Agriculture, No. 316; Experiment Station contribution No. 668*).—The experiment was carried out in the forage field of the College of Agriculture. Can cultures were used except for the experiment on the effect of seasons in which thirteen plots five square meters in area were employed.

The objects of the experiments were to find out the effect of fertilizers, lime, inoculation, drainage, terravim soil inoculation, seasons, and irrigation on the growth and production of alfalfa. The last one was on the possibility of making alfalfa hay.

The results show that lime used alone increased the production of alfalfa by 59.0 per cent. Without lime, complete fertilizers gave a yield of 7.8 per cent over the check. Lime and potassium increased the yield of lime alone by 28.0 per cent; while lime mixed with potassium and phosphorous increased the effect of lime alone by 19.0 per cent.

Inoculation with a pure culture of alfalfa bacteria further increased the yield obtained by fertilizers. The average of this increase was 30.8 grams. In the absence of good drainage, the yield from inoculation was lower than that of well drained soil. It was found that bacteria inoculation and terravim soil inoculation gave about the same yield.

Any kind of treatment was less effective if the plants were not planted in the right season. The best month for planting was November. The yield of plants from 5 square meters was 1.065 kilograms, or 2,130 kilograms to the hectare. The average temperature was 25.7°C. and the average monthly rainfall was 56.1 mm. Other months in the order of their importance were August, October, and December. The results from other months showed that too much rainfall or drought was detrimental to alfalfa.

An experiment on irrigation showed that a plot of 5 square meters gave a yield of 3.73 kilograms fresh plants, or 7,526 kilograms to the hectare. The author claimed that this yield is high compared with that of unirrigated ground. His method of irrigation was by watering the plants every morning with a sprinkler.

In making alfalfa hay, drying the legume for one day was enough in January to April.

—*Abstract by Baldomero G. Salinas.*

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[1] Abstract prepared as part of required work in English 6, College of Agriculture.

NOTE: CELEBRATION OF THE TWENTIETH ANNIVERSARY OF THE SCHOOL OF FORESTRY

Favored with good weather, the celebration held on June 14-15, 1930, to commemorate the twentieth anniversary of the founding of the school of Forestry and to dedicate the new Forest School building was a complete success. At 8:00 o'clock on the morning of Saturday, June 14, the parade, which was one of the best ever seen in Los Baños, started from the junction of the College and Provincial roads. Among those taking part were the elementary schools of Bay and Los Baños; Laguna Institute; Laguna Academy; Veterans of the Revolution with float and members of the Red Cross; Timber Licensees of Laguna with float and a band; provincial officials of Laguna; College of Agriculture with its float and members of the faculty; College of Veterinary Science with its float and members of the faculty and student body; the School of Forestry with its float, cadets, members of the faculty and alumni. It took two hours to reach the School of Forestry, where a board of Judges, after careful deliberation, awarded the first prize for the most artistic float to that of the Timber Licensees of Laguna, the College of Agriculture receiving honorable mention. At 10:00 o'clock a. m. the anniversary program was held. Among the speakers were President Palma, Governor Tomas Dizon of Laguna, and the Honorable Jaime C. de Veyra, author of the law creating the School of Forestry. Messages were read from His Excellency, Governor-General Dwight F. Davis, Senate-President Quezon, and Senator Osmeña. Other features of the program were a vocal solo by Miss Rosario Dumlao and a violin solo by Professor Cayetano Jacobe. At noon the official luncheon was served in the Forestry Mess Hall. Among the guests were a number of high University and other government officials and lumbermen. In the afternoon, the School of Forestry building was formally dedicated with appropriate ceremonies. This was followed by various athletic games. At night a reception and ball was held at the Mess Hall. For those who did not care to go to the dance, a native drama was staged on the Forestry Campus.

Sunday morning, June 15, was featured by an alumni reunion, at which about two hundred graduates gathered together and formed an Alumni Association. Many graduates from different parts of the Islands, most of them not having seen the school since their graduation, came purposely for this occasion. The officers elected were Cecilio Maneja, '13, President; Placido Dacanay, '14, Vice-President, and Macario A. Mariano, '15, Secretary-Treasurer. This meeting was followed by athletic games and a barbecue at noon. In the afternoon, the memorial exercises were held in honor of the twenty-two graduates and others who have died in the service.

Among the speakers were Representative Arsenio Bonifacio of the second district of Laguna, Forest Supervisor Eladio C. Leaño, Forester Placido Dacanay, Forester Carlos Sulit, and Professor Carlos P. Romulo of the *Philippine Tribune*. The special feature of this program was the floral offering made by nineteen young ladies each representing a class from 1912 to 1930. To appropriate music, wreaths were placed by these young ladies at the foot of the cenotaph especially erected in front of, the School Building. On Sunday night there was a torch parade by the students of the Associated Colleges of Los Baños from the College of Agriculture campus to the School of Forestry. This was followed by a bonfire program. The celebration closed with the staging, by the Senior students of the School of Forestry, of a playlet which was dramatized by Professor Anne M. Pendleton from a chapter of one of Harold Titus' books, entitled "Timber".

Throughout the celebration, there was an educational and commerical exhibit in which the Colleges of Agriculture and Veterinary Science, the School and Bureau of Forestry, and the towns of Magdalena and Paete participated. The booth of the College of Agriculture was awarded first prize, with that of Paete receiving honorable mention.

The celebration, in so far as attracting the attention of the public to the cause of Forestry is concerned, was a complete success. No less than five thousand people attended the celebration. As early as Friday, June 13, about 30 tents were pitched on the campus to help in the accommodation of visitors. Two brass bands furnished lively music in addition to a string band and an orchestra which played on the programs and for the dancing.

Before the celebration, newspaper articles acquainted the public with what was going on on the School Campus. An editorial on the "Constructive Service" of the School of Forestry appeared in the *Philippine Tribune* of June 14. This was followed the next day by a special anniversary edition of the same paper, one thousand copies of which were distributed to those attending the celebration. This edition contained various articles on Forestry by alumni of the School and members of the Bureau of Forestry.

CARLOS SULIT
Of the School of Forestry

"I thought life in the College of Agriculture was as easy as to put the rice in the mouth, but really it is extremely hard. I thought studying the scientific method of farming was by observation and examination only, but in fact I myself have to handle the tool used."

Extract from a letter written to his father, June, 1930 by a College of Agriculture freshman.

EXCHANGE NOTES

It has been the custom in the West Indies to soak banana suckers for 48 hours before planting, as a precaution against banana borer. Mr. H. W. Simmonds, Government Entomologist of Fiji, informs us that he has carried out a series of experiments with the object of obtaining clean suckers from infected plants, and finds that it is possible to do this by immersing them to a depth about four inches above the point where the aerial stem joins the corm, leaving the remainder of the plant exposed to the air and allowing it to remain in the water for a period of 21 days. Care must be taken not to immerse the sucker totally or the plant will die.

Experiments showed that mature larvae are able to pupate and survive a period of 14 days immersion, which period was sufficient to kill the suckers themselves, when these were totally immersed, but by allowing the top to remain free the sucker can survive a period of 21 days, which is sufficient to destroy all the borers in the plants.

—*Tropical Agriculture.*

American ingenuity has turned its attention to the art of cheese making with the result that even Roquefort, that district in Southern France which has been famous for its delicious cheese for more than 800 years, may soon find the United States a closed market.

Air conditioning equipment, temperature controls and processing devices have produced under American conditions, cheeses that even a connoisseur would hesitate to pronounce domestic. . .

The United States now has almost three thousand cheese factories. With the five thousand creameries and three hundred condenseries and evaporated milk plants, they form America's greatest industry, doing a five billion dollar annual business and outranking the automobile industry, this country's next greatest, by a billion dollars a year. . .

Roquefort, unchallenged for eight centuries as the home of the world's finest cheese, was studied. No other sheep raising district in the world has conditions that prevail in Roquefort where an accident eight hundred years ago led to the discovery of what has since been known as Roquefort cheese.

A shepherd tending his flocks, hid his lunch of bread and native cheese of sheep's milk in a cave, intending to return for it when he was hungry. Something intervened and he did not find his way back to the cavern for several weeks. The bread was spoiled and the cheese was covered with a curious green mold. The shepherd was hungry, however, and he nibbled at the cheese. Great was his surprise at the unusual and pleasing flavor.

Later generations are fortunate that he was curious of mind and decided to see if he could produce more cheese of the same flavor.

The Roquefort caves owe their unusual properties to the cool moist air that flows perpetually through them. The end away from the mouth of the cave connects with a fissure that admits air from the surface heavy in moisture and never varying in temperature. The environment happens to be ideal for the propagation of the vegetable mold which gives Roquefort cheese its peculiar quality.

The production in America of a cheese so similar to Roquefort that few can tell the difference was attempted many times since 1851 when the first cheese factories began operations here, but ultimate success awaited developments in other unrelated industries. No way of controlling humidity and temperature simultaneously occurred to the cheese makers until the perfection for factories, schools, theatres and other places, of air conditioning equipment which produced atmospheric conditions most desirable for comfort. Then there remained only the application of such equipment to the needs of the cheese industry.

—*The Farmer and Stockman.*

The University of Idaho has a Holstein purebred cow that recently made a new record for senior three-year-olds on a seven day test: 788.8 pounds of milk or a daily average of 112.6 pounds or 52½ quarts a day. It contained 18.9 pounds of fat or 23.6 pounds of butter.

—*California Cultivator.*

The largest nitrogen fixation plant in the western hemisphere, greatly increases the industrial and military independence of the United States. It is situated at Hopewell, Virginia, on the James River, eighty miles from Hampton Roads. This plant converts daily 350 tons of inert nitrogen gas of the atmosphere into sodium nitrate and anhydrous ammonia for peacetime industrial uses. But if the United States were at war, the plant would largely free her from the necessity of getting Chile saltpeter from South America for fertilizer, explosives and essential chemical industries.

—*Science.*

Illinois had more farmers to turn in complete records of accounting at the university than any state in the union. More than 1,900 books with the figures of the farm businesses have been inspected at the College of Agriculture, since January 1.

—*The Prairie Farmer.*

COLLEGE AND ALUMNI NOTES

Doctor Stevens, Baker Memorial Professor, delivered the first of his series of semi-popular lectures on the evening of July 9, in the lecture hall of the Department of Agronomy. The subject was "Travel Talk on Central and South America". Maps, lantern slide illustrations, and interesting incidents, with much valuable information cast the spell of a real trip over the audience. Each individual went home feeling that he had been traveling in those old Spanish colonies for which the Filipinos have some feeling of kinship.

Professor and Mrs. Elmer Roberts of the University of Illinois were Campus visitors in early July. Doctor Roberts is head of the Genetics Department of the University of Illinois. He spent the greater part of last year in Hopei, China, in investigation on bacillary white diarrhea among chickens.

Doctor and Mrs. Roberts with Judge and Mrs. Serafin Hilado were honor guests at a luncheon given by Dean Gonzalez. The other guests were Dr. and Mrs. F. L. Stevens, of the faculty of the University of Illinois, Mrs. Mariano Jugo, Dr. and Mrs. Sixto Francisco, Dr. and Mrs. Alexander Gordon, Dr. and Mrs. Miguel Manresa, all former students in Illinois University.

Mr. Fred C. Hadden, assistant entomologist of the Hawaiian Sugar Planters' Association, has recently arrived in the Philippines from Honolulu. He has established his headquarters on the College Campus, where he expects to stay for about two years for the purpose of securing for introduction into Hawaii, propagating material of certain species of *Tiphia*, a scoliid wasp which is parasitic on white grubs.

In a letter received by Doctor Uichanco from Mr. Tei Ishii, assistant entomologist of the Imperial Agricultural Experiment Station, Tokyo, he states that he is on his way for a third visit to the Philippines for the purpose of securing parasites for rice stalk borers for colonization in Japan. Mr. Tei Ishii is sailing for China and French Indo-China about the end of July, where he plans to spend some three months before he comes to the Islands.

On the evening of June 28 a dinner was given in Molawin Hall by the faculties of the Los Baños Colleges with Rev. and Mrs. Hugh Bousman and

Mr. E. D. Hester as honor guests. Mr. and Mrs. Bousman sailed on July 11 on the *President Pierce* for the homeland and Mr. Hester recently returned to the Islands as United States Trade Commissioner, so the dinner was a combination of "May you have a pleasant vacation" and "Glad to see you back". Mr. Bousman as Student Pastor, ably assisted by Mrs. Bousman has accomplished in the three years he has been here work remarkable for its amount and still more remarkable for its quality. The dinner was an expression, in a measure, of the appreciation of the community for the achievement of "The Bousmans" and to assure them of a hearty welcome back at the end of their year's furlough.

All who are familiar with the past ten years' history of the College know of Mr. Hester's work in the institution and why the faculty and old students rejoiced when he came back "home".

Miss Katherine Turner recently appointed instructor in English arrived from Europe in June. Miss Turner who received the degree A. B. from the University of California, was on the staff of an International Fellowship School in Switzerland the past year.

The fifty-third scientific meeting of the Los Baños Biological Club was held on June 26, 1930, at 7:30 p. m., in the Lecture Hall of the Department of Agricultural Chemistry.

The following papers were read and discussed:

> The use of antimony electrode in the control of cane juice defecation and the determination of the hydrogen ion concentration of soils. By Mr. N. Galvez.
>
> Epizoötic lymphangitis and glanders among Filipino ponies with special reference to the occurrence of mixed infection. By Doctors A. K. Gomez and Z. de Jesus, Paper read by Doctor Gomez.

This is the second year that the Department of Agricultural Education has been in charge of the Maquiling School. Although not a part of the Department it is one of the necessary enterprises of the College of Agriculture and the Department assumes the responsibility for its administration and supervision; the school has its own teachers and is supported entirely from tuition fees paid by the patrons who for the most part are faculty members. Originally started in 1924 as a kindergarten it now has an enrollment of eighteen in the primary grades and seven in the intermediate. Beginning with one teacher it now employs two teachers full time and a third on a part time contract; the monthly pay roll is above ₱160. In early years the tuition rate once reached ₱17.50 per month, but the rate has now been reduced to ₱5.00 for the kindergarten, ₱6.00 for the first two grades and ₱10.00 for other grades. The school has a cash balance of about

₱500.00 and is paying all current expenses from the tuition. It is quite probable that some further reductions will be made in tuition before the middle of the year as the school is strictly non-profit. It is the ideal of the Board of Directors (all of whom are senior faculty members) that this shall be a school to which the faculty may send their children and be certain that they are receiving as high standard instruction as they could get elsewhere.

Miss Anne Cole of the Department of English is again Director of the Mimics. Miss Cole's work for the past two years with this dramatic club has been of outstanding quality not only in the plays presented but in the work done in the weekly meetings.

Miss Turner of the Department of English will direct the College Sing this year.

The U. P. Rural High School opened classes for the second year with an enrollment of 64 in First Year, 91 in Second Year, 31 in Third Year and 26 in special preparatory classes—212 in all. The low enrollment in First Year was made possible by the larger number of advanced pupils transferring from other schools. There are thirty girls enrolled.

The Department of Agricultural Education was pleased to note in the July number of the *Country Gentleman* that among the seven pictures from the Philippines one is of the department building and one of the U. P. R. H. S. girls.

Miss Turner has been appointed Adviser for the Associated Women Students of the Los Baños Colleges.

ET TU, BRUTE[1]

Whenever newspapers and popular periodicals relapse into slovenly treatment of news regarding scientific matters, we are prone to dismiss the offence with a superior smile. We may condone it as the work of high-pressure journalists who, owing to the nature of their calling, cannot be expected to do any better. We, however, expect a higher grade of reporting in reputable scientific journals and similar publications. Because of their acknowledged standing, they have come to be looked upon with almost pathetically blind faith by the unsuspecting layman as the fountain-head of authoritative learned information. For them to commit avoidable blunders in recording scientific items of general interest, when verification could easily be made with very little extra effort, is a cruel violation of the public's confidence.

Yet of late we notice this very thing happening with disquieting frequency. To cite only two very recent examples:

In the fourteenth edition, published in 1929, of the *Encyclopedia Britannica*, which is an accepted standard work of reference the world over for all branches of human knowledge, the following item appears in volume 21, page 753:

"Tagalog, a tribe of eastern Mindanao in the Philippines, formerly head hunters, particularly on occasions of the deaths of prominent tribesmen; they made wood or stone figures to accommodate the souls of deceased persons. (*Relación de las Islas Filipinas*, anon., *c.* 1595.)"

Again in *Science*, volume 71, No. 1844, Friday, May 2, 1930. This journal is "a weekly journal devoted to the advancement of science" and is "the official organ of the American Association for the Advancement of Science." Here is what it says on page XIV in connection with the typhoon which struck the island of Leyte on April 18, 1930:

"From such storms America is protected as the Orient will not be for years because of the stable character of the buildings in this country. The typhoon reaps a huge harvest of dead among the inhabitants of the frail houseboats which swarm together in floating cities.

"Then there are many lines of communication in America by which warnings and news can be sent and relief rushed to the stricken area before disease has a chance to take a foothold. But even if the Far East had all these advantages, the loss of life would be great merely because the population is so dense and there are so many people to strike in any area."

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[1] General Contribution from the College of Agriculture No. 272.

Such scientific travesties would disgrace even the Sunday editions of popular papers. We are said to be living in a wonderful age. One side of the world knows what the other side is doing. Rapid intercourse between continents by air. land or water and efficient communication service with such modern conveniences as post-offices, telephone, telegraph, cable, and radio have made Rip Van Winkles out of place in our present scheme of life. Well stocked public libraries are accessible in any civilized community, perhaps even in England and in America, where the two passages quoted above were edited and published. Certainly there is no longer any excuse for resorting to pipe dreams or to a four-century old book written by an anonymous author of patently questionable veracity for sources of scientific information.

Incidentally, it may be worth noting, at least in the interest of accuracy, that Luzon, where the Tagalogs have their home, and Mindanao are two distinct islands which are situated at opposite ends of the Philippine Archipelago. Their two nearest ports, Manila and Zamboanga, are 512 nautical miles distant from each other The Tagalogs may have been head hunters at one time; but it needs a more sound evidence to substantiate this point than that furnished by the unknown chronicler of 1595. The earliest Spaniards who came in contact with these people, in 1570, Martin de Goiti and Juan de Salcedo, found them established in settled villages and possessing a civilization which was basically of Hindu influence and in which all traces of the practice of head hunting or making wood and stone images in order to accommodate souls, if this practice ever existed, had long become effaced.

Likewise, when the houseboats and floating cities were attributed to the Philippines, some one was badly mixed up in geography. As to the factor of comparative density of population, it seems strange that a typhoon would strike more people in the Philippines with 91 to a square mile than in the United States with 241. And in regard to the number of lines of communication, telegraphic messages transmitted from one place may be received in most of the inhabited parts of the country within a couple of hours; steamships, railroads, and even aeroplanes are not a rarity here; and, what is more, the Islands are not far behind the United States in fatalities from automobile accidents!

L. B. Uichanco,
Of the Department of Entomology.

RELATION OF NUTRIENTS TO PERITHECIAL PRODUCTION UNDER ULTRA-VIOLET IRRADIATION

F. L. STEVENS

Professor of Plant Pathology, University of Illinois, Urbana, Charles Fuller Baker Memorial Professor (1930-1931 of Plant Pathology), University of the Philippines

WITH THREE TEXT FIGURES

In 1928[1] a preliminary announcement was made of the sexogenetic effect of ultra-violet irradiation upon *Glomerella cingulata.* A more comprehensive account showing the wave lengths involved, the dosage required, and the effect of irradiation on certain other fungi was published in 1928.[2] Other articles under the following titles are now in press or in manuscript and will appear in due time. The titles give sufficient indication of their scope.

The response to ultra-violet irradiation shown by various races of Glomerella cingulata. In press in the American Journal of Botany.

The ascigerous stage of Colletotrichum lagenarium induced by ultra-violet irradiation. In press in Mycologia.

Further observations regarding ultra-violet irradiation and perithecial development. The Philippine Agriculturist.

The effects of ultra-violet irradiation on various Ascomycetes, etc. In manuscript.

The aim of this article is to record the results of experiments made to ascertain whether or not the sexogenetic response to irradiation may be altered, increased or decreased, by the application of nutrient or other substances to the media upon which the fungus was grown. For this purpose three strains, among others, of *G. cingulata* of the following characters were used:

G 9-2 which produced perithecia whether irradiated or not.

G 10-15 which produced perithecia when irradiated and only then.

G 2-12 which has never been seen to produce perithecia under any conditions.

These were tested by the addition of various chemicals to determine the relation between the nutrients provided and the perithecial response due to irradiation.

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[1] Stevens, F. L. 1928. The sexual stage of fungi induced by ultra-violet rays. Science, n. s. **67**: 514–515.

[2] Stevens, F. L. 1928. Effects of ultra-violet radiation on various fungi. Botanical Gazette **86**: 210–225.

G 10-15 WHICH GAVE PERITHECIA ONLY ON IRRADIATION

Corn meal agar and potato dextrose agar[3]; two series of varying percentages were prepared. The results are given in the following table:

TABLE 1

Showing perithecial production by G 10·15 on various agars. The figures show the number of perithecia per low power field, i.e., approximately 4 sq. mm

MEDIA	NUMBER OF PERITHECIA PRODUCED	
	Irradiated	Non-irradiated
Plain agar	2–7	0
10 per cent corn meal agar	35	0
25 per cent corn meal agar	50	0
50 per cent corn meal agar	50	0
75 per cent corn meal agar	30–50	0
100 per cent corn meal agar	30–50	0
10 per cent potato dextrose agar	200–400	0
25 per cent potato dextrose agar	250–450	0
50 per cent potato dextrose agar	200–450	0
75 per cent potato dextrose agar	Very many	0

It is seen that plain agar gave only few perithecia on irradiation and that potato dextrose gave many more than did corn meal agar; in the latter medium the number increased rather consistently with the nutrient provided.

In the following tests G 10-15 was inoculated upon plates of plain agar and the colony allowed to attain suitable size, usually about 5-6 cm. in diameter. The nutrients, in small quantity, an oese, were added as shown in figure 1. The following records show the results several days after irradiation.

Sucrose. Applied immediately after irradiation. Twenty hours later large increase in conidial production and growth was noted on the irradiated side in the region affected by the application of the sugar. Eight days later numerous perithecia had matured on the irradiated side, none on the non-irradiated side.

Sucrose. Applied 24 hours before irradiation. Results as above.

Raffinose. Applied immediately after irradiation. Regions showing stimulation of growth were much smaller than with the previous sugar, possibly due to difference in diffusion. More perithecia were produced on the irradiated side where the stimulating effect of the sugar appeared, but this difference was not so marked as with the previous sugar.

Raffinose. Applied 24 hours before irradiation. Results as above.

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[3] Both Difco preparations.

Levulose. Applied immediately after irradiation. Growth stimulation slight, abundant perithecia on the irradiated side.

Levulose. Applied 24 hours before irradiation. Results as above.

Lactose. Applied immediately after irradiation. Very little growth stimulation. Perithecia somewhat increased by the sugar.

Lactose. Applied 24 hours before irradiation. Results as above.

Galactose. Results as with lactose.

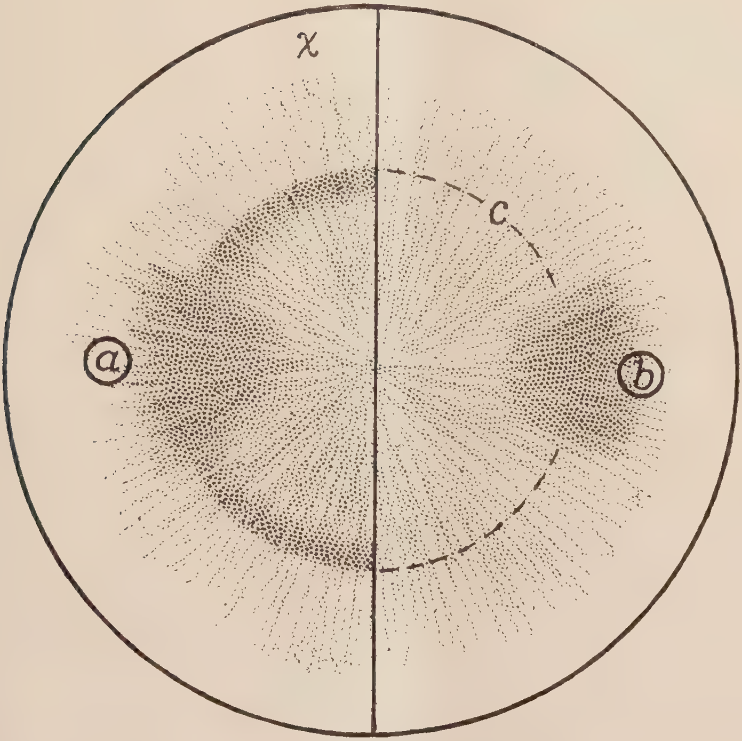

Fig. 1.—Showing manner of applying nutrients; *c* edge of colony when nutrients were added at points *a* and *b*; *x* the irradiated half of the plate. The shaded areas near *a* and *b* indicate the increased growth in these regions.

Maltose. Applied immediately after irradiation. Growth stimulated to a considerable extent, but only over a small area evidently because of slow diffusion of the sugar. Very marked increase in conidial production in the affected area. Perithecia found in large clumps.

Maltose. Applied 24 hours before irradiation. Results as above.

Summary regarding responses of G 10-15 to sugars

In general, conidial production was much greater on the irradiated side than on the non-irradiated side both when irradiation preceded or followed the application of sugar. Since a time interval was needed for the mycelium to assimilate the nutriment and thus become responsive to irradiation, in general no perithecia were developed after two days when irradiation preceded feeding, though they did develop in this time on the irradiated side in large numbers when irradiation took place 24 hours after the sugar was applied.

All the sugars favored mycelial growth, strongly in case of sucrose, levulose, maltose, less so in case of raffinose, lactose, galactose. Perithecial formation on irradiation was enabled by sucrose, levulose, maltose, to a less extent by raffinose, lactose, galactose. There is general agreement in that those sugars that most favored growth also most increased perithecial production upon irradiation.

G 9-2 WHICH USUALLY MADE PERITHECIA WHETHER IRRADIATED OR NOT

Table 2 shows general agreement with table 1 regarding G 10-15 as to utilization of these foods though there was a slight difference between these two strains in this regard.

TABLE 2

Showing perithecial production by G 9-2 on various agars. The figures show the numbers of perithecia per low power field

MEDIA	NUMBER OF PERITHECIA PRODUCED	
	Irradiated	Non-irradiated
Plain agar	0	0
10 per cent corn meal agar	25– 70	25– 70
25 per cent corn meal agar	50– 60	25– 30
50 per cent corn meal agar	20– 70	30–100
75 per cent corn meal agar	175–300	175–300
100 per cent corn meal agar	230–400	230–400
10 per cent potato dextrose agar	275	275
25 per cent potato dextrose agar	500–700	500–700
50 per cent potato dextrose agar	550–900	550–900
75 per cent potato dextrose agar	500–900	500–900
100 per cent potato dextrose agar	900	900

Tests on plain agar were made as follows:

Sucrose. Applied immediately after irradiation. After one day a large increase in conidial production occurred on the irradiated side near the sugar, growth was much increased, more than by any other sugar. Perithecia formed only in sugar regions, and were equal in number in the irradiated and non-irradiated areas.

Sucrose. Applied 24 hours before irradiating. Results as above.

Raffinose. Results same as for sucrose.

Levulose. Results same as for sucrose, except that perithecia were formed in much smaller numbers.

Lactose. Slight increase in growth. No perithecia in irradiated or non-irradiated areas.

Galactose. Slight effect on growth. Perithecia numerous in all stimulated areas.

Maltose. Growth almost equal to that produced by sucrose, otherwise as with galactose.

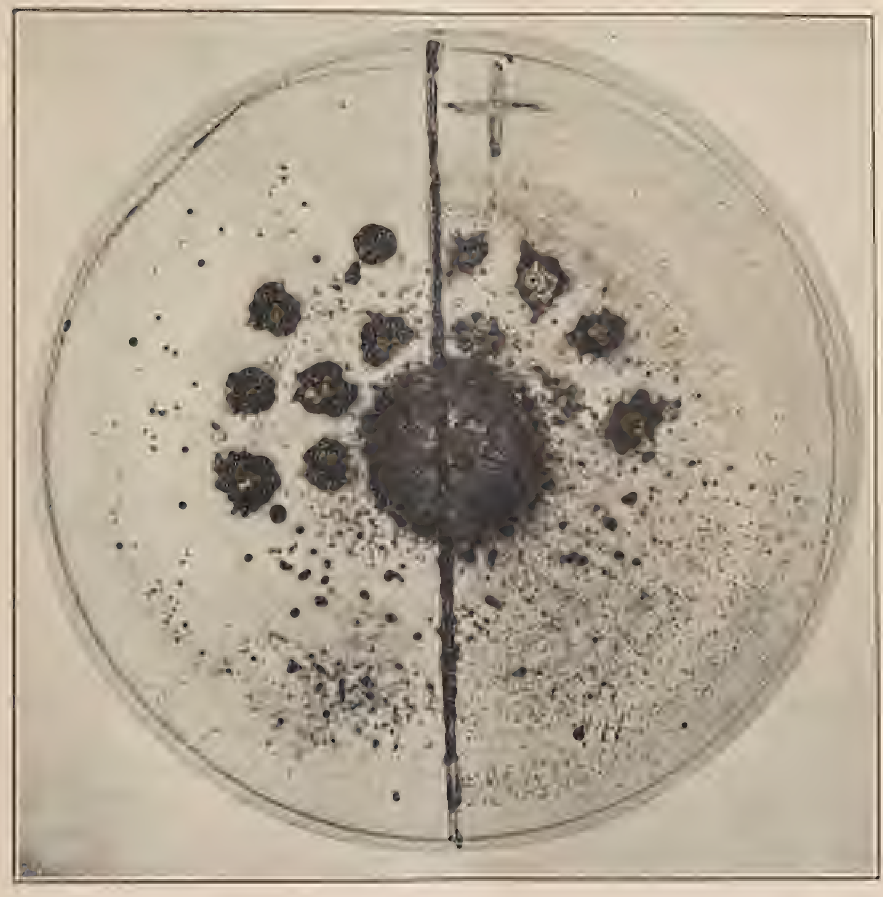

Fig. 2.– G 10-15 showing effect of drops of cod-liver oil on the colony.

Summary regarding reaction of G 9-2 sugars

Perithecia developed quite abundantly on both irradiated and non-irradiated sides of the colony, but only on the part receiving the nutrient in the case of all sugars except lactose where no perithecia were found on either irradiated or non-irradiated areas. The nutritive values of these sugars to G 9-2 were about the same as they are to G 10-15.

G 2-12 WHICH HAS NEVER BEEN SEEN TO FORM PERITHECIA UNDER ANY CIRCUMSTANCES

This strain was tested in all of the strengths of corn meal agar and potato dextrose agar, both with and without irradiation, which are given in table 1, but in no instance were perithecia seen. This strain was also grown with all of the sugars and under all of the conditions related for strain G 10-15 on previous pages, but in no case were perithecia seen in either irradiated or non-irradiated regions. On sucrose appressoria were abundant, on raffinose and galactose not so abundant.

G 13, WHICH USUALLY IN PLAIN AGAR GAVE NO PERITHECIA

This strain, on irradiated or non-irradiated areas on 10 per cent, 25 per cent, 50 per cent, 75 per cent corn meal agar, gave no perithecia; on 100 per cent corn meal agar a few perithecia developed on the irradiated side, none on the non-irradiated side.

REGARDING VITAMINES

Thinking that perhaps ultra-violet irradiation may have produced vitamines in the cultures which may have led to the production of perithecia, various vitamin-rich substances were added in drops upon an eight-day colony of G 10-15 on corn meal agar as is shown in figure 2.

Yeast, vitamin B, autoclaved at 15 pounds for 15 minutes applied thus gave no results. Tomato, vitamin C, lemon and orange, vitamin C, juices gave no perithecia on the non-irradiated side and either decreased or inhibited their production on the irradiated side.

Ergosterol in oil, cod-liver oil, vitamins A and B, or Wesson oil applied in drops on the colony resulted shortly in very black spots (fig. 2), coincident with the area covered by the oil. These regions owed their appearance to excessive development and blackening of the mycelium, but no perithecia developed. The conidial development was almost suppressed. Alcoholic solution of ergosterol gave no perithecia on the non-irradiated region. When irradiated, fewer perithecia were produced in the immediate vicinity of the applied ergosterol or cod-liver oil than at a distance from these applications, this probably being due to exhaustion of the mycelium by excessive growth.

In some instances the black spots due to cod-liver oil showed characteristic structure of acervuli except that rather numerous setae were present. The setae were dark, septate, and about 95 μ long.

G. lagenarium reacted to cod-liver oil in the same way as did G 10-15.

Summary regarding vitamine tests

No effect of vitamines upon the production of perithecia was observed, either when applied with or without irradiation.

Though the new growth of mycelium from an irradiated and, therefore, perithecigerous area of colony of G 10-15 never bore perithecia, certain isolated observations made it appear probable that under some conditions the perithecigerous character might be carried over to new growth. To test this, portions of an irradiated perithecial colony and of a non-irradiated non-perithecial colony were cut out and laid upon a sterile corn meal agar plate in the manner shown in figure 3. Sixty irradiated and sixty non-irradiated regions were thus transferred. The irradiated transfers resulted in nine distinct perithecial outgrowths; the non-irradiated transfers in none. The perithecia thus produced in the new growth were at considerable distance from the colony, for example, 80, 110 and 155 μ. Irradiated pieces applied are as effective fifteen minutes after irradiation as at longer intervals. Though this response, when it occurs, is unmistakable, in many instances it does not occur.

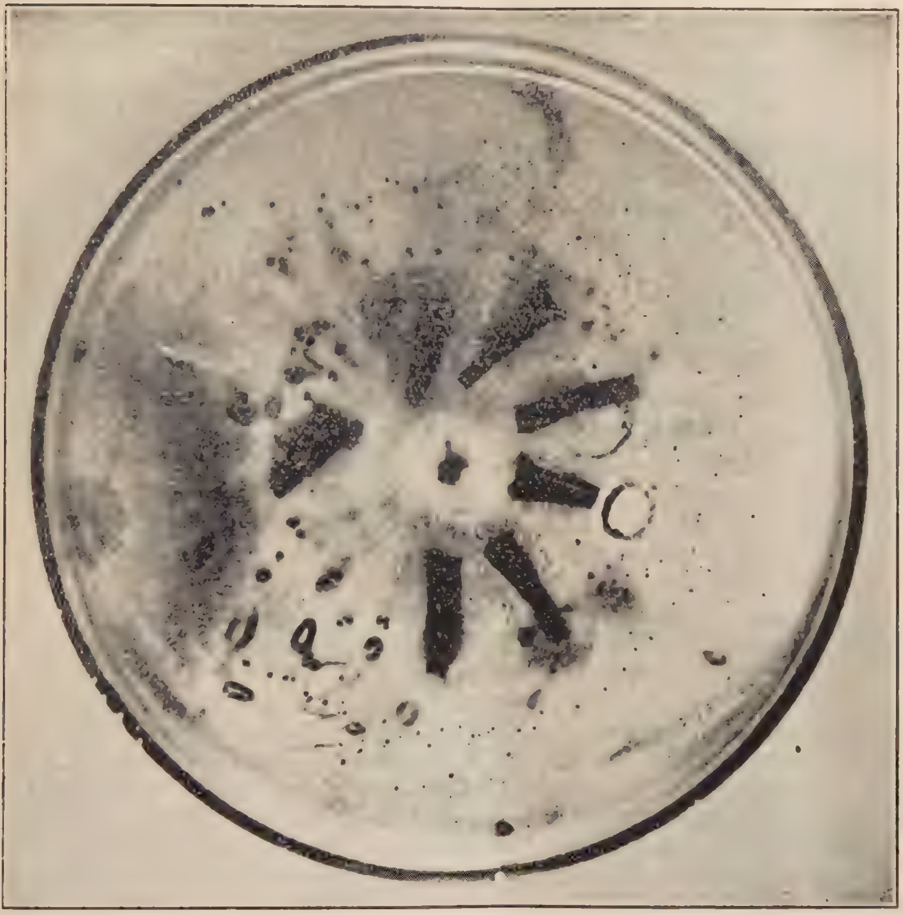

Fig 3.—Showing the method of laying on pieces of an irradiated colony.

The live mycelium was more effective in this way than when sterilized. Though these experiments are not conclusive, it appears possible that irradiation which induces perithecial production may cause the production within the fungus of a substance which renders new outgrowths from the mycelium to be perithecial.

"Onlays" made in similar manner, by laying the irradiated pieces on a colony of G 10-15, using "layons" that were one hour, 3, 6 and 11 days old after irradiation and applied to colonies 7, 9, 12 and 14 days old gave only negative results.

Irradiated mycelium grown in flasks of corn meal broth was ground in quartz sand 4 hours, 24 hours, 6, 8, and 15 days after irradiation and sterilized by 100° C. for one hour, or by acetone, ether, etc. Other material was used without sterilization. Extracts of these preparations were placed upon colonies of G 10-15, but no perithecial development was observed, though the added nutriment increased formation of acervuli.

A series of tests was tried using G 2-12, which was never known to produce perithecia under any conditions (see p. 270, ¶ 1), on plain agar and with an oese of certain nutrients added on each half of the plate. One-half of the plate was irradiated 30 seconds one day after the application of the nutrient, the other half was not irradiated. No difference due to the nutrients was observed when raffinose, dextrine, soluble starch, casein, sodium asparaginate, diasparagine, caffeine, magnesium sulfate or salsoda were used. In the case of Merck's pepsin, U. S. P. powder, however, it was found that a few perithecia formed in the neighborhood of the pepsin on the irradiated area, but not on the non-irradiated area.

A similar series of tests of G 2-12 was made on corn meal agar. No differences were noted in perithecial production due to casein, sodium asparaginate, di-asparagine and caffeine.

In the case of pepsin, raffinose and magnesium sulfate perithecia were formed on the irradiated portion of the plate though not on the non-irradiated portion. The pepsin was consistent and uniform in giving this response, the other two much less so. These results are especially striking since this strain has given perithecia under no other conditions, and since the three substances which did render the fungus capable of perithecial response when irradiated, (with a negative result when not irradiated); namely "pepsin", raffinose when applied on corn meal agar, and magnesium sulfate, are of such diverse nature.

Various poisons as mercuric chloride, nitric acid, phenol, potassium hydroxide, calcium chloride and formalin were similarly tested. They repelled and distorted the mycelium but no perithecia resulted in any case.

An attempt to cause G 10-15, which gave perithecia only when irradiated, to produce perithecia merely by adding various chemicals or nutrients was made in the manner of the experiments related above. Though potassium hydroxide, calcium chloride, arsenic, formalin, nitric acid, phenol, potassium cyanide, alcohol, calcium sulfate, mercuric chloride, leucin, were applied no perithecia resulted in any instance.

EPIZOÖTIC LYMPHANGITIS AND GLANDERS AMONG PHILIPPINE PONIES WITH SPECIAL REFERENCE TO THE OCCURRENCE OF MIXED INFECTIONS[1]

A. K. GOMEZ AND Z. DE JESUS
Of the College of Veterinary Science

WITH THREE TEXT FIGURES

Epizoötic lymphangitis, commonly known in the Philippine Islands as *botones*, is an infectious disease of equines characterized by a purulent inflammation of the superficial lymph glands and vessels. It is caused by a specific yeast, *Blastomyces farciminosus*, which is infective, but not readily transmissible to man. Glanders, or *muermo*, is another infectious disease of solipeds characterized by the development of purulent nodules with a tendency to ulceration, particularly in the skin and mucous membranes, caused by a rod-shaped micro-organism, the *Pfeifferella mallei*. This disease is readily transmissible and very fatal to human beings. Both diseases are quite prevalent among Philippine ponies. They occur also in other countries as France, England, Egypt, Union of South Africa, Italy, Japan, India, etc. The external manifestations of these two diseases are very similar, and, when they co-exist in the same animal, this condition of mixed infection is extremely difficult to recognize clinically. In fact, Pallin (1908) in a treatise on epizootic lymphangitis states:

> The disease has from time immemorial been invariably confounded with glanders (farcy) and ulcerative lymphangitis, in whatever part of the world it has appeared, and even with the assistance of mallein and modern science, veterinarians of every nationality still continue to make the same mistakes.

HISTORY OF EPIZOÖTIC LYMPHANGITIS AND GLANDERS

In 1872, Rivolta, using the pus obtained from lesions of epizoötic lymphangitis cases, demonstrated the presence of the yeast now known as *Blastomyces farciminosus*. But it was not until twenty years later that Tokishige, who extensively investigated this disease in Japan, successfully isolated and cultivated the causative agent in pure culture. In 1902, Richard P. Strong reported the appearance in the Philippines of a disease resembling glanders. He determined the cause of the disease to be a *Blastomyces*, and there is no doubt that he was dealing with epizoötic lymphangitis. So far as we know, this is the first record of the existence of this malady in the Philippine Islands. The infection was probably introduced by army horses imported from China, as it is known that this disease existed in that country many years previous to American occupation of these Islands.

Glanders is one of the oldest known diseases, its recognition dating back to several centuries before Christ. The specific micro-organism was

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[1] Experiment Station contribution No. 672. Read before the Los Baños Biological Club, June 26, 1930. Received for publication, July 1, 1930.

discovered by Loeffler and Schuzt in 1882. Since the very early days, its transmissibility to man has been recognized. Glanders appears to have been first reported in the Philippines by United States Army veterinarians. Dr. John G. Slee, Chief of the Veterinary Division of the Board of Health, United States Army, in his annual report for September 1, 1903, to August 31, 1904, states that out of 3,764 army horses imported into Manila, 165 were condemned for glanders, killed and cremated. Dr. John Ernst, veterinarian, Quartermaster's Department, United States Army, in his report for the Philippine Division for the fiscal year ending June 30, 1904, gives the following as the number of animals that died of or were condemned for glanders:

ANIMALS	NUMBER	DIED OF OR CONDEMNED FOR GLANDERS
Horses	4,759	294
Mules	2,183	70
Total	6,942	364

PREVALENCE

Through the kindness of Dr. Victor Buencamino, a veterinary practitioner in Manila, who courteously submitted for our inspection his files for the last fourteen years of records of cases received for treatment in his hospital, the following data showing the relative proportion of epizoötic lymphangitis and glanders were obtained:

TABLE 1

Relative proportions of epizoötic lymphangitis and glanders under urban conditions

YEAR	HORSES	EPIZOÖTIC LYMPHANGITIS	GLANDERS
1916	1,181	18	10
1917	2,093	34	18
1918	1,678	44	27
1919	1,491	64	25
1920	1,608	52	14
1921	1,569	59	13
1922	1,263	34	5
1923	580	23	1
1924	666	14	7
1925	550	15	14
1926	710	31	9
1927	443	11	10
1928	341	8	8
1929	277	8	8
Totals	14,450	415	169
Percentages		2.87+	1.15+

Table 1 represents the relative proportion of the two diseases among horses received for treatment under urban conditions. It will be noted that there were 2.87+ per cent cases of epizoötic lymphangitis and 1.15+ per cent glanders. These percentages are markedly different under rural conditions as will be seen in table 2, data for which were obtained from records of the College of Veterinary Science for the last nine years.

TABLE 2

Relative proportions of epizoötic lymphangitis and glanders under rural conditions

YEAR	HORSES	EPIZOÖTIC LYMPHANGITIS	GLANDERS
1920	61	0	0
1921	129	4	6
1922	338	22	1
1923	178	30	0
1924	638	64	2
1925	88	11	1
1926	613	112	2
1927	99	7	0
1928	54	2	0
1929	599	49	1
Totals.........	2,797	301	13
Percentages....		14.33+	0.46+

It will be noted in table 2 that the percentage of epizoötic lymphangitis is 14.34+ and of glanders 0.46+. Under rural conditions, therefore, the relative proportion of epizoötic lymphangitis to glanders is very much greater than in the city. This greater proportion can be explained by the fact that many diseases such as lamenesses and digestive disturbances which are of common occurrence among horses in the city are not prevalent in the country.

On the other hand, table 2 shows a relatively lower incidence of glanders than table 1. In the city where the majority of the stables are dark, filthy, and crowded, the propagation of a bacterial disease as glanders is naturally favored. *Blastomyces farciminosus* being a resistant fungus can survive under varied climatic conditions outside of the animal body while *Pfeifferella mallei* is very susceptible to the action of sunlight and is easily killed outside the body. These characteristics of the two micro-organisms explain, in large measure, the observed differences in their prevalence in the city and in the country.

MIXED INFECTIONS

The only statement regarding the occurrence of cases of mixed infection of epizoötic lymphangitis and glanders, previous to the present report, was made by Pallin (1908) who stated that Tixier and Delamotte had been misled by the co-existence of these two diseases among their patients; this caused them to finally conclude that African farcy was identical to glanders (farcy). Pallin states, also, that in the history of these two diseases this error has been repeated again and again. In India, in 1899, and in South Africa, during the Boer war, epizoötic lymphangitis and glanders were frequently taken as manifestations of the same disease (glanders) because the former was not then recognized as a separate entity, and in many cases, their co-existence was not even suspected. In France, the unity of the different forms of farcy was acknowledged and African farcy was considered to be an attenuated form of glanders until 1872 when Rivolta discovered the specific organism of epizoötic lymphangitis.

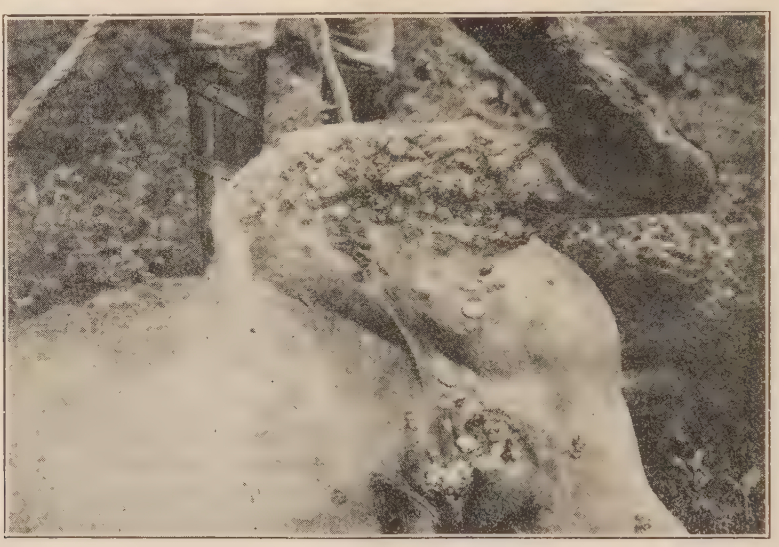

Fig. 1.—An advanced case of epizoötic lymphangitis, showing lesions on the inner surface of the thigh and on the scrotum and prepuce.

The following cases of mixed infection positively diagnosed by the writers were discovered in horses received for treatment in the clinics of the College of Veterinary Science.

Protocol of cases

Case.—No. 220.
Date.—August 29, 1921.
Signalment.—Light bay, male, native pony, 7 years.
History.—The animal has been sick with *botones* for some time.
Symptoms.—Various nodular swellings and fungoid ulcers, ranging in size from that of a pea to that of a five centavo piece, are present in both fetlocks, the medial surface of the thighs, on the scrotum, at the commissures of the lips, the gums and the alae of the nostrils. A muco-purulent nasal discharge is present. The animal is emaciated.
Diagnosis.—Glanders and epizoötic lymphangitis.

Treatment.—No treatment was given as the animal was suspected of glanders. A disc of ophthalmic mallein was placed in the right conjunctival sac. The following morning a marked positive reaction was obtained. The animal was condemned.

Pus from an abscess was examined in smears stained with Gram stain and the presence of *Blastomyces farciminosus* was revealed.

Case.—No. 10.
Date.—January 13, 1925.
Owner.—Mr. M. Raymundo.
Signalment.—Bay, native mare, about 8 years.

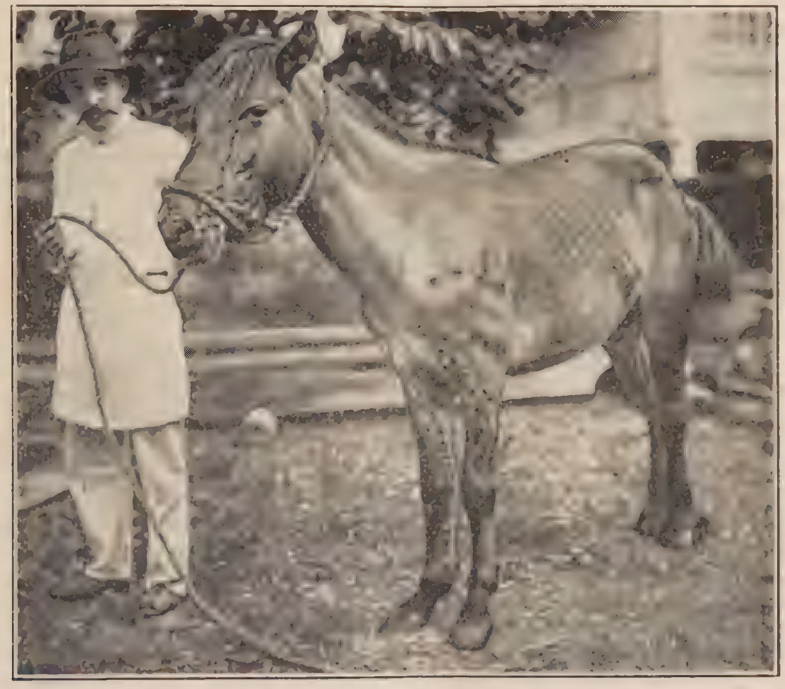

Fig. 2.—A case of glanders showing positive reaction to ophthalmic mallein test. Note the muco-purulent discharge from the eye and the skin lesions.

History.—A month previous to the presentation of the case, nodules of varying sizes appeared on the back of the animal. Some of them have ruptured discharging a thick creamy pus. The animal was kept on the College Campus (Agricultural College, Laguna), but, for two weeks before appearance of symptoms, was kept in Santa Cruz, Laguna, where the infection must have been obtained.

Symptoms.—The animal has a nice smooth coat except for a few areas of alopecia at the mane and the tail. There are several nodules of varying sizes on the back and the thorax. The largest is as large as an orange. Four of these nodules have ruptured and are discharging a thick creamy pus. The precrural and inguinal glands are markedly swollen, the left ones being more prominent. They are very sensitive to the touch. Marked lameness is noticed when the animal is made to walk.

Diagnosis.—Epizoötic lymphangitis and glanders.

Treatment.—This consisted of the internal administration of potassium iodide, 7 grams daily until symptoms of iodism were noticed. The treatment was discontinued for several days and repeated when symptoms abated. The ulcers were disinfected with 1:1000 solution of bichloride of mercury, dried with a piece of cotton and then anointed with a creoline salve. The abscesses were incised, squeezed to remove the pus, and then a small piece of copper sulfate crystal was inserted into the cavity and retained in place by a plug of cotton. After one or two days, the plug and all necrotic tissue were removed with a curette and the resulting ulcer was treated like the rest.

This treatment was begun January 13, 1925, and continued to May 22, 1925 when the suspicion of glanders arose, owing to the persistence of the lesions notwithstanding prolonged treatment. The conjunctival mallein test was applied and a positive reaction was obtained. This was further confirmed by the Strauss reaction. Four male guinea pigs were inoculated intraperitoneally with 1 mil of a clear emulsion of pus obtained from an abscess located at the lumbar region on May 22, 1925. Six days later, all the guinea pigs developed an acute glanderous orchitis. They were killed and a pure culture of *Pfeifferella mallei* was isolated from the testicular pus.

A subculture of this isolated organism was later inoculated intraperitoneally into three other male guinea pigs and two of these subsequently developed glanderous orchitis while the third one survived the inoculation.

The horse was, therefore, condemned and destroyed. On autopsy, there were found several abscesses in the mediastinal lymph glands which contained a honey-like pus characteristic of glanders.

Case.—No. 61.
Date.—February 8, 1927.
Owner.—Mr. Lorenzo Alcasid.
Signalment.—Gray, native, male pony, 9 years.
History.—According to the owner, eight months previous to the examination of the animal, a few nodules or *botones* developed on the right side of the body but were apparently cured by the common native treatment consisting of a local application of calcium carbide. A week ago, however, several nodules the size of a pigeon's egg appeared at the base of the neck on the right side.
Symptoms.—There are several hard and fluctuating abscesses at the base of the neck, at the pre-scapular and precrural lymph glands which are painless to the touch.
Diagnosis.—Epizoötic lymphangitis and glanders.
Treatment.—Blue ointment was applied to the hard nodules and those fluctuating were incised and disinfected. Internal medication consisted of the administration of 7 grams of potassium iodide daily. This treatment was discontinued on February 13, 1927, when glanders was suspected and positively diagnosed by means of the subcutaneous mallein test. The horse was condemned and destroyed.

Case.—No. 104.
Date.—December 17, 1929.
Owner.—Mr. Fernando Ordoveza.
Signalment.—Gray, native, male pony, about 11 years.
History.—No previous history.
Symptoms.—There are various swellings ranging in size from that of a pigeon's to that of a hen's egg on the left side of the neck. One is, also, present on the right side. They are soft, slightly painful and hot on palpation. A ruptured abscess discharging a creamy pus is seen at the angle of the right mandible. On the medial aspect of the left tarsal region, there is an indurated and deep-seated abscess.
Diagnosis.—Epizoötic lymphangitis and glanders.
Treatment.—Surgical incision of the abscesses, disinfection of the ulcers with 1:1000 solution of bichloride of mercury and the application of Villate's mixture. This treatment

continued to December 26, 1929, when the co-existence of glanders was suspected. Three male guinea pigs were inoculated subcutaneously with ½ mil of the supernatant liquid from an emulsion of pus in sterile saline. The pus was obtained from a recently incised abscess. Five days later, all the three pigs developed acute glanderous orchitis. One was found dead five days after the inoculation and the other two were chloroformed and from the testicular pus of one of them a pure culture of *Pfeifferella mallei* was isolated.

DISCUSSION

In a report of acute glanders in man, Musgrave and Sison (1913) state the following:

> When one considers the very contagious character of this infection, together with the very close association between human beings and horses, particularly in the Philippine Islands and most tropical countries, it is surprising that human glanders is not more frequently encountered. The four cases from Manila would suggest a greater incidence than is particularly recognized in this country.

In recent years, the importance of animal diseases transmissible to man is being more realized and a greater number of these diseases are being discovered, not that many of them have not existed probably for generations but the attention of veterinarians had not been attracted to this line of investigation until lately. The rapid development of veterinary science has opened up this fertile field of research. Of the diseases common to animals and man that are at the present time the subject of active investigation, the following may be mentioned;—"psittacosis", "undulant fever", "tularemia", "septic sore throat", "glanders', "tuberculosis", "anthrax", "rabies", etc.

Again, to quote Musgrave and Sison (1915):

> Most physicians never have seen a case *of glanders* (italics are ours) and it, therefore, is not included in the routine picture that one examines in connection with cases of fever, rheumatic pains, and skin lesions.
>
> Glanders is most frequently mistaken for dengue fever, syphilis, typhoid fever, and less frequently for pleurisy, pneumonia, and certain skin diseases, particularly impetigo contagiosa, pemphigus, or ecthyma.

From these words, it may be inferred that many cases of glanders in man may have escaped recognition. Conditions for the transmission of the infection to man, particularly in the Philippines, are favorable. One often meets a coachman or owner of horses who claims with a certain degree of pride that he can positively cure either *botones* or *muermo.* His acquaintance with epizoötic lymphangitis, a disease of far more common occurrence in horses in the Philippines than glanders and which yields to simple remedies, has given him the idea that these two diseases are identical. Moreover, many veterinarians fail to recognize cases of mixed infection; the danger lurking in them as a source of infection is very evident.

The four cases of mixed infection described in this paper were discovered in horses brought for treatment to the clinics of the College of

Veterinary Science, Los Baños, Laguna. In three of them the lesions of epizoötic lymphangitis were so pronounced as to mask those of glanders, hence the co-existence of the latter disease was not suspected and established till later when no results were obtained from continuous and prolonged treatment. The students who handled these cases did not contract glanders because proper routine disinfection was observed and *Pfeifferella mallei* is known to be very readily killed by any disinfectant of ordinary strength.

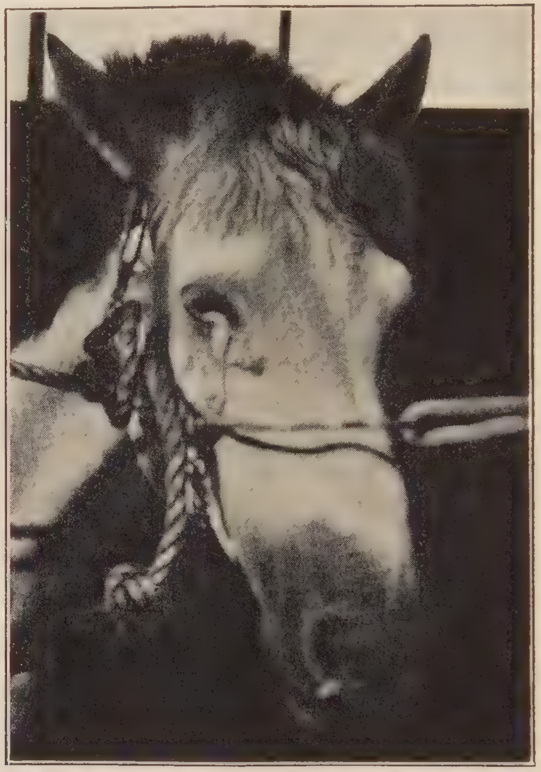

Fig. 3.—A case of glanders showing marked positive reaction to ophthalmic mallein test. Note the mucopurulent discharge driveling from the inner canthus of the eye.

However, the danger to human life existed up to the time that the diagnosis of glanders was established to co-exist and the animals were killed and buried.

Because of the possibility of glanders being present it is advisable, as a routine measure, to test all cases of epizoötic lymphangitis for the possible co-existence of glanders before administering treatment so as to preclude any danger arising from the presence of this disease. Of the many mallein tests in vogue, we recommend the use of the ophthalmic mallein discs as a practical, simple and reasonably correct (90 to 94 per cent) test. It is carried out by introducing a disc of mallein into the conjunctival sac of a healthy looking eye and gently massaging it till the disc dissolves. A positive reaction appears within six to twelve hours; it consists of a mucopurulent discharge from the inner canthus of the eye, which adheres to the lower lid and sometimes runs down the cheek. In some cases edema of the lids, marked congestion of the conjunctiva and sticking together of both lids occur. (See fig. 2 and 3.)

We also recommend the use of the intrapalpebral mallein test, as this was extensively used by the United States Army during the World War and proved to be advantageous in many respects. It consists in the injection of a drop of diluted crude mallein into the lower eyelid and observing the production of an acute inflammation of the eye within six to twelve hours.

SUMMARY

1. Epizoötic lymphangitis and glanders are prevalent diseases among horses in the Philippine Islands, the first being the more predominant.
2. Under rural conditions epizoötic lymphangitis shows a very much greater incidence than glanders.
3. For the first time in the Islands, four positively diagnosed cases of mixed infection of epizoötic lymphangitis and glanders are reported and attention is called to them as a probable and very dangerous source of infection to man.
4. As a routine measure, it is recommended that before any treatment is administered all cases of epizoötic lymphangitis in the Philippines should be tested for the possible co-existence of glanders.

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MARKETING COCONUT PRODUCTS IN TAYABAS AND LAGUNA[1]

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An analysis of the methods of marketing coconut products that are followed by the farmers in Tayabas and Laguna might help in finding remedies for their troubles in selling their produce. It was this idea that prompted the writer to undertake this study of the marketing of coconut products in these two provinces which form the greatest coconut region in the Philippine Islands.

The work was conducted from the farmer's point of view; that is, the marketing of copra and coconuts only was studied, as these are the principal coconut products that concern the farmers. Other important coconut products, such as oil, desiccated coconut, and copra meal do not concern the farmers as they are products manufactured in factories.

A work of similar nature, but only for copra, was published in THE PHILIPPINE AGRICULTURIST of March, 1930. This work, however, was confined to one of the towns of Tayabas Province. The present work embraces a wider area and is not confined to copra alone.

This study was conducted in the provinces of Tayabas and Laguna during the periods from April 3 to 14, and May 2 to 5, 1930.

In gathering the information the inquiry method was used, that is, producers, merchants, transportation men, government officials, bank officials and employees of some companies were questioned about practices that are followed in the buying and selling of copra and coconuts, the methods by which these products are transported from the plantations to the mills or markets, and their cost of production.

MARKETING

Preparing products for market

Copra. The methods of preparing copra for the market are much alike throughout the provinces of Tayabas and Laguna. For descriptions of practices in Lucena, Tayabas, *see* Mabbun (1930)[2].

Coconuts. The nuts are picked, piled in a convenient place, and husked. They are then ready for market. The laborers who do this work are paid cash wages.

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For the courtesy shown and information furnished by the farmers, government officials, coconut and copra dealers, bank officiales, and the employees of the desiccated coconut factories in Tayabas and Laguna, the writer expresses grateful appreciation.

[2] Mabbun, Pablo N. 1930. A study of the marketing of copra in Lucena, Tayabas. THE PHILIPPINE AGRICULTURIST 18: 621–633.

Transportation

The facilities employed in transporting farm products sometimes determine the share of the farmer of the proceeds from the sale. When a farm product is hauled to market by truck or railroad the farmer usually receives a larger share of the cash returns than when it is transported in bull-carts, on carabaos' backs, or on men's shoulders.

Husked nuts are hauled in bull-carts pulled by carabaos from the interior plantations to either the nearest provincial road or railroad station. From the road they are transported by truck to the desiccated coconut factory which had purchased them. From the station they are shipped to the town nearest the factory which bought them; and hauled from the station to the mill by truck. In and around Pagsanjan, unhusked nuts are arranged in rafts and floated on the Pagsanjan River to the desiccated coconut factory in that town.

Terms of sales

Copra. The geographical relation of Laguna and Tayabas is such that in the copra industry they are as one, And the copra for the most part is sold to the same buyers; the principal ones being Compañia General de Tabacos de Filipinas, Manila Export Corporation, Philippine Refining Company, Luzon Industrial Corporation, Bio Chuan and Company, San Pablo Oil Mills, Jao Cui Pien and Company, and Carrero Vidal and Company.

There are several individual buyers who purchase copra in both provinces. For terms of sale *see* Mabbun (1930).

Nuts. Buyers pay cash for coconuts on delivery. Tenants receive their share in cash.

Methods of sale

Copra. For the methods of sale of copra *see* Mabbun (1930).

Nuts. As with the copra, nuts are sold either directly to the desiccated coconut factories or through one or more middlemen. There are six of these factories which demand whole nuts for the manufacture of desiccated coconut for export to the United States. The names of these factories are:

1. Franklin Baker Company, Mill No. 1, San Pablo, Laguna.
2. Franklin Baker Company, Mill No. 2, San Pablo, Laguna.
3. Franklin Baker Company, Mill No. 3, Santa Mesa, Manila.
4. Blue Bar Coconut Company, Pagsanjan, Laguna.
5. Red V Coconut Products Ltd., Magdalena, Laguna.
6. Tayabas Coconut Company, Candelaria, Tayabas.

The combined capacity of these factories is around 600,000 nuts daily. The presence of four of these mills in Laguna has decreased considerably the copra production in that province.

Middlemen. When the coconut producer is himself a "contractor", that is, buys nuts for a desiccated coconut factory he sells directly to the factory. His contract calls for the delivery to the factory of so many thousand nuts within a certain period of time for so much a thousand. Naturally, he sells his nuts first.

Contractors or middlemen purchase nuts from different farmers in the towns near the factory. For economy in transportation they assemble these nuts at certain points, then have them hauled to the factory in trucks.

When the nuts in one locality are not sufficient to meet the demand of the contractor, he employs assistants on commission to buy nuts in more distant towns. These assistants send the nuts they buy either directly to the factory under the name of their employer or to the nearest railroad station whence these are shipped to the factory, under the care of their employer.

Co-operative marketing. There are no co-operative marketing associations among the coconut planters in these two provinces. The farmers sell their produce independent of one another. There is competition among them; they undersell one another, with the result that they receive ruinous low prices for their crop.

The fixing of prices

The price quotations for copra at the local shipping centers are based on the daily market reports of the Philippine Bureau of Commerce and Industry. Generally, the basis of the local quotation in Tayabas is the price quoted in the market report for the *corriente mejorado* copra and in Laguna that for *corriente* copra.

The buyers of copra in Tayabas and Laguna offer but one price for this commodity at each of the local shipping centers, regardless of the quality of the product. The price quoted at the Lucena railroad station, where the commission merchants have warehouses, serves as the basis for buying and selling copra in Tayabas, and the price quoted at San Pablo serves as the basis for buying and selling copra in Laguna.

In the study of prices, the writer found that despite the higher cost of transportation because of greater distance to Manila, the price paid for copra in Tayabas was generally higher than in Laguna. For instance, when conducting this investigation, copra was selling at ₱8.40 a picul in Tayabas and ₱8.00 in Laguna. Nuts, husked, sold for ₱30 a thousand in each province.

The reason for the higher price in Tayabas is because copra in that province is generally admitted to be of better quality than that in Laguna.

It should be understood that the price quoted at the local shipping center for copra is the maximum that the buyers can offer for any quality of copra offered for sale. When the farmer delivers his copra at the local shipping point, he receives this price. But when he sells his copra to a middleman, he gets less than the quoted price; how much less depends on how many middlemen will handle the product before it reaches the local shipping center. If the middleman who buys his copra is the commission merchant representing the exporter at the local shipping point, he receives the quoted price minus the traveling expenses of this middleman from the local shipping center to the farm and return and the cost of transporting the copra from the farm to the station and his commission. If the copra passes through the hands of more than one middlemen the selling price of the copra is lowered accordingly.

Although the desiccated coconut factories offer only one price for nuts, regardless of size, the middlemen doing the buying for these factories sometimes pay according to the size of the nuts. This practice enables the middleman to make more profit than if he bought the nuts at one price, regardless of size, for he delivers these nuts at the factory at one price, according to contract. To illustrate: Suppose contractor A contracts to deliver one million nuts to desiccated coconut factory B within three months at ₱34 a thousand. Now, A offers to the farmers one price, say ₱30 a thousand, for the larger nuts and, say ₱26 a thousand, for the smaller nuts. Consequently, A makes ₱4 for every 1,000 large nuts purchased by him and ₱8 for every 1,000 small nuts. He mixes these nuts and delivers them to the factory at the contract price of ₱34. So, it is very clear that the farmer is at the mercy of the buyers, whether he sells his produce in the form of copra or in whole nuts.

Marketing costs

For purposes of clearness in this paper marketing costs are divided into two groups: (1) expenses borne by the farmer, and (2) expenses borne by the buyer. Marketing costs may be summarized thus:

Copra

Part borne by the farmer:

Items	*Pesos per picul*	
	Tayabas	*Laguna*
Cost of hauling copra to road	₱0.30	₱0.15
Cost of hauling from road to railroad station at shipping center	0.20	0.20
Cost of weighing at station	0.03	0.03
Total	₱0.53	₱0.38

Part borne by the buyer:

Items	*Pesos per Picul*	
	Tayabas	*Laguna*
Cost of loading in freight cars	₱0.10	₱0.10
Internal Revenue tax	0.03	0.03
Freight charges	0.35	0.28
Total	₱0.48	₱0.41

Summary:

Expenses borne by the farmer	₱0.53	₱0.38
Expenses borne by the buyer	0.48	0.41
Total	₱1.01	₱0.79

Nuts

Part borne by the farmer:

Items	*Pesos per 1,000 nuts* *Tayabas*	 *Laguna*
Cost of harvesting	₱1.00	₱0.80
Cost of picking	0.25	0.25
Cost of husking	1.00	0.90
Cost of hauling to nearest provincial road or railroad station	1.50	1.50
Total	₱3.75	₱3.45
Calculating the copra at the rate of 4 piculs per 1,000 nuts in Tayabas and 3.5 piculs in Laguna, the cost per picul is	₱0.94	₱0.99

Part borne by the buyer:

Items		
Cost of loading on freight cars	₱0.42	₱0.42
Internal Revenue tax based on copra	0.12	0.11
Freight charges	1.92	1.20
Total	₱2.46	₱1.73
Cost per picul of copra when amount of copra per 1,000 nuts is the same as calculated above	₱0.61	₱0.49

Summary:

Expenses borne by the farmer	₱3.75	₱3.45
Expenses borne by the buyer	2.46	1.73
Total	₱6.21	₱5.18

Financing production and marketing

Private capital. As a general rule, the farmers in Tayabas and Laguna furnish their own capital for producing nuts and copra. There are, however, some who borrow money from copra and nut dealers with the understanding that the loans are to be paid back in copra at a price from ₱0.50 to ₱1.00 a picul or in nuts ₱0.50 to ₱1.00 a 1000 nuts less than the current price at the time of settlement. It is also understood that all expense for hauling the product used in paying the loan will be borne by the borrower.

There are tenants to whom money is advanced by their landlords on their share of the copra produced on the plantations in their care. Generally, these tenants deliver to the landlord one picul of copra, or its equivalent in nuts, for every ₱5.00 advanced to them.

Some of the contractors who buy nuts for the desiccated coconut factories are advanced as high as fifty per cent of the cost of the nuts they agree to deliver to the factory or factories with which they sign a contract. This money is used to pay for the nuts. The factory is protected by securities in the form of titles to land, etc., or written guarantee secured by signatures of two or more responsible property owners known to the company.

Bank loans. There is a branch of the Philippine National Bank in Lucena, Tayabas, and a branch of the People's Bank and Trust Company in San Pablo, Laguna. The Philippine National Bank lends money on real estate mortgages to coconut and copra dealers in both provinces. It also has ₱30,000 annual reserve for crop loans to farmers. But very little of this money is ever borrowed. The farmers do not borrow for crop production but for purposes of buying land, equipment, and other permanent improvements. For security for such loans they give real estate mortgages. Most of the loans run for five years or longer. Interest on all loans is ten per cent.

The People's Bank and Trust Company in San Pablo lends on real estate mortgages to both farmers and to coconut dealers. As to how much this bank lends annually, as crop loans to farmers, the writer was not able to ascertain.

VOLUME OF COPRA AND NUTS SHIPPED BY RAILROAD AND FREIGHT CHARGES

The bulk of copra and coconuts is shipped by railroad. Records were obtained of shipments of these products from January 1 to March 31, 1930, from all the important stations lying between San Pablo, Laguna, and Lucena, Tayabas. The object was to determine the freight charges and to get an idea of the quantities of these commodities shipped by this means of transportation. Tables 1 and 2 show the volumes of railroad shipments of nuts and copra during this period.

COST OF PRODUCTION

A farmer should know how much it costs him to produce a unit of the product he handles before he can intelligently consider methods of marketing. Knowing this cost, the farmer is in a position to estimate the price at which he should sell his crop so as to make a reasonable profit.

The writer attempted to make estimates of the cost of production of some of the most important coconut products in Tayabas and Laguna. The results of these estimates are shown in tables 3, 4, and 5.

It should be understood that the figures do not by any means represent the exact cost of production of these commodities. Cost of production for a single commodity varies not only in localities but even in the same place. It is believed however that the estimates are very close to what it costs the majority of the farmers to produce copra and coconuts in the two provinces surveyed.

In computing cost of production, data were gathered from representative farmers in the two provinces and then only the figures found to be quoted by the large majority of the farmers interviewed were used.

The estimates are based on 1,000 nuts supposed to be harvested from 100 trees planted on one-half hectare of land. Nuts are harvested, on the average, four times a year, or once every three months. The nuts are supposed to yield an average of 4 piculs of copra under Tayabas conditions and 3.5 piculs under Laguna conditions. The land is supposed to be second class with an assessed value of ₱105 a hectare; the trees are also supposed to be second class with an assessed value of ₱4.50 each. The market value of a tree is supposed to be ₱5. As tools and implements used in the preparation of the product for market belong to hired labor, the only basis of expense on depreciation is the *tapahan.* This building, however, is considered only in the case of copra as it is not used for whole nuts. The average *tapahan* is given a value of ₱30 with an annual depreciation of 10 per cent. There are generally no other buildings on the coconut plantations.

Copra. Table 3 shows that it costs ₱3.96 to produce a picul of copra in Tayabas and ₱4.53 in Laguna. Adding to these figures the cost of marketing borne by the farmer, the amount is ₱4.49 in Tayabas and ₱4.91 in Laguna, the total cost of production of a picul of copra in each of the provinces.

The fact that in Tayabas 1,000 nuts yield an average of 4 piculs of copra, while in Laguna they yield only 3.5 piculs, explains the difference in cost.

Considering that the market price of copra was ₱8.40 a picul in Tayabas and ₱8.00 in Laguna at the time of the investigation, it is evident that the copra producers in Tayabas who sold directly to the commission merchants at the local shipping center made a profit of ₱3.91 for every picul sold, and those in Laguna, ₱3.09.

Nuts. Table 4 shows that it costs ₱14.85 in Tayabas and ₱14.55 in Laguna to produce and market 1,000 nuts. With ₱30 per 1,000 as the market price of nuts in the two provinces at the time of this study, it is evident that the farmers in Tayabas gained ₱15.15 and those in Laguna ₱15.45 for every 1,000 nuts they sold.

It appears from the data in table 4 that it is more advantageous for the farmers in Laguna to sell their crop in the form of whole nuts than as copra, as the profit is more. The coconut producers in Tayabas, however, should produce copra rather than sell whole nuts. The reasons for this are twofold: (1) In Laguna 1,000 nuts yield an average of 3.5 piculs of copra, hence, the higher cost of production, but when sold as whole nuts the price in the two provinces is the same. (2) It is generally accepted that Tayabas copra is of better quality than that of Laguna, hence, commands a higher price. Whether or not the farmers realize this the writer can not say. But apparently the coconut planters in Laguna prefer to sell nuts to making copra, while those of Tayabas produce copra. This preference is probably why the desiccated coconut factories have increased to four in Laguna, and they are large ones too, while the one factory in Candelaria, Tayabas, has remained a small mill with no increase since 1922.

Desiccated coconut. While this study is on the marketing of coconut products from the point of view of the farmer, it may not be amiss to give some facts in connection with the approximate cost of producing desiccated coconut, the manufactured product of the nuts sold by the farmers. Basing calculation on meagre information furnished by four of the six desiccated coconut factories located in Laguna and Tayabas, the writer tried to determine how much it costs to produce a pound of desiccated coconut product. Table 5 shows the result of this calculation.

Desiccated coconut is exported solely to the United States. The writer was told that a case (box) of the finest desiccated coconut product —macaroon—weighing 140 pounds sells for about ₱50 when all expenses are included, while the coarser product sells for one-third less.

FARMER'S INCOME

Knowing the cost of producing a picul of copra or 1,000 nuts, the natural question is "What is the farmer's profit?" Taking as a unit a hectare of coconut plantation of 200 trees with a yearly yield of 40 nuts each the writer will try to answer this question for each of three types of farmer; namely, (1) the landowner who farms his land—the proprietor-farmer; (2) the landowner who employs tenants—the landlord; and (3) the tenant-farmer.

1. *The proprietor-farmer.* Table 6 shows the expenses and income of the landowner who farms his own land. The table indicates the amount that this type of farmer, when working under both Tayabas and Laguna conditions, spends for the production and marketing of copra if he sells whole nuts from one hectare.

2. *The landlord.* There are two types of share tenancy commonly practiced by coconut planters in Tayabas and Laguna. These are: (1) the three fourths-one fourth basis, and (2) the two thirds-one third form. Under the first system, the expenses for preparing the product for market are defrayed by both the landlord and the tenant. These expenses are deducted from the receipts and the remainder is divided into four equal parts. Three parts go to the landlord and the fourth part to the tenant. The system really gives three-fourths of the burden of expense of preparing the product for market to the landlord, and one-fourth to the tenant. The second system holds the tenant responsible for all expenses incurred in the preparation of the product for market. After the product is ready for sale, it is divided into three equal parts. Two parts go to the landlord and the remaining third part goes to the tenant.

Table 7 shows the expenses and income of the landlord from nuts and copra.

3. *The tenant-farmer.* Table 8 shows the costs and income of a tenant from one hectare under the two types of share tenancy.

A further examination of the data for both landlord and tenant reveals that, from the landlord's point of view, it is more advantageous to produce and sell copra or nuts under the two thirds-one third share system than under the three fourths-one fourth basis. From the tenant's point of view, however, it is more advantageous to work under the three fourths-one fourth basis than under the two thirds-one third form. The difference of advantage in favor of either party, however, is not very great. This equality of advantage justifies the prevalence of the two systems of share tenancy in the two provinces.

Under the two systems of share tenancy both the landlord and the tenant in Tayabas gain more by producing and selling copra than nuts, whereas in Laguna both parties make more money by producing and selling nuts than copra.

SUMMARY AND CONCLUSIONS

In common with farmers in all parts of the world marketing is the most serious problem of the Filipino farmer today. That he is very poorly informed about the facts and conditions surrounding his field of marketing adds to his difficulties. Studies leading to the analyses of the methods used by the farmer in marketing his crops and of the costs of production will help in giving the Filipino farmer aid in his marketing difficulties. In this study of the marketing of coconut products in Tayabas and Laguna, certain points should be emphasized. They are:

1. Copra and nuts pass through the hands of from one to four middlemen in moving from the farm to the exporter. This increases the cost of marketing thereby decreasing the farmer's share of the consumer's peso, because each of these middlemen must be paid, and this pay must come out of the final selling price, or the consumer's buying price. Consolidation of marketing under one management, as in a co-operative organization, would eliminate part at least of the middleman's receipts. This amount could go to the farmers.

2. Because the farmers compete among themselves, because they undersell one another, they generally receive for their produce prices which are much lower than the actual market quotations. The farmers can influence the fixing of prices only by controlling the output or supply. This control is feasible in a co-operative marketing association. Rules and regulations can be adopted by the association that would regulate and improve the marketing activities of the coconut farmers. Once production is under their control, the farmers can force the buyers to pay the prices fixed by their co-operative association.

3. Under the present system of marketing copra and coconuts in Tayabas and Laguna, commission merchants to assemble copra foı economical shipment to the exporters and contractors to buy nuts for the desiccated coconut factories are necessary. The work done by assistants employed by these commission merchants and contractors could be done by the farmers themselves if they would inform themselves as to the demands of the middlemen. Then the money that is paid to these assistants could be retained by the farmers. To illustrate: Suppose commission merchant, A employs B on commission as his assistant to purchase copra in distant places. Now, suppose that the market price of copra is ₱8.40 a picul. If

A buys the copra from the farmer he pays for it, let us say, ₱7.90. The difference between ₱8.40 and ₱7.90, or ₱0.50, represents the traveling expenses of A, his commission, and cost of transporting the copra from the farm to the shipping point. But if B buys the copra, because the farmer does not know that A buys this product, naturally, B would pay him, let us say ₱7.50 instead of ₱7.90; the ₱0.40 difference representing the traveling expenses of B and his commission. If the farmer knows A and what he wants, then, he could sell his copra to him direct. He would then get ₱7.90 for every picul sold instead of ₱7.50. The same principle applies to nuts when they are bought from the farmer by assistants of the contractor.

4. The Laguna farmers spend ₱4.91 and the Tayabas farmers, ₱4.49 to produce and market a picul of copra. The cost of production is higher in Laguna than in Tayabas because in Laguna 1,000 nuts yield only 3.5 piculs of copra while in Tayabas the same number of nuts yield 4 piculs. Tayabas copra, moreover, generally sells at a higher price than that from Laguna. At the time of this investigation the market price of copra was ₱8.40 a picul in Tayabas giving a profit to the producers of ₱3.91 for every picul sold, while in Laguna it was ₱8.00 a picul, allowing a profit of ₱3.09, provided of course that the producers sold directly to the commission merchants at the local shipping centers.

The cost of production of nuts is 30 centavos higher in Tayabas than in Laguna. The market price is the same in the two provinces. It is more advantageous for the Laguna farmers to sell their produce in the whole-nut form than as copra, but the Tayabas farmers should stick to their practice of making copra instead of selling the nuts. These statements explain why there are four desiccated coconut factories in Laguna and only one in Tayabas.

5. Basing calculation on the estimates of cost of production of a picul of copra and 1,000 nuts, the net income of each of the three types of farmer from one hectare of coconut plantation containing 200 trees each yielding 40 nuts a year is given as follows:

(*a*) A proprietor-farmer in Tayabas receives a net income of ₱141.16 from copra, or ₱121.20 from nuts; the same type of farmer in Laguna makes ₱93.00 from copra, or ₱123.00 from nuts.

(*b*) A landlord whose land is in Tayabas and who is employing tenants under the three fourths-one fourth share basis gets a net income of ₱102.92 from copra, or ₱88.70 from nuts. The same landlord when employing tenants under the two thirds-one third share basis has a net income of ₱107.40 from copra, or ₱91.20 from nuts.

A landlord whose land is in Laguna and who employs tenants under the three fourths-one fourth share basis receives a net income of ₱66.80 from copra, or ₱90.50 from nuts. The same landlord when employing tenants under the two thirds-one third share basis receives a net income of ₱77.53 from copra, or ₱91.20 from nuts.

(*c*) A tenant working on a Tayabas plantation under the three fourths-one fourth share system gets a net income of ₱38.24 from copra, or ₱32.50 from nuts. The same tenant when working under the two thirds-one third share basis receives a net income of ₱33.76 from copra, or ₱30.00 from nuts.

A tenant working on a Laguna plantation under the three fourths-one fourth share basis gets a net income of ₱26.20 from copra, or ₱33.10 from nuts. The same tenant when working under the two thirds-one third share system receives a net income of ₱15.47 from copra, or ₱32.40 from nuts.

On the incomes given above, for a tenant in these two provinces to maintain a standard of living equal to that of the average Filipino laborer or farmer, who lives on ₱1.00 a day, he should have a plantation of at least 12 hectares. This area properly cared for would absorb all his time so he could have no other source of income from labor. As a matter of fact the average Filipino tenant, as well as the peasant proprietor, engages in secondary occupations which yield him some income. This explains why the average family in Tayabas and Laguna takes care of only from 200 to 1,000 trees, or plantations ranging from two to five hectares.

6. The three fourths-one fourth and the two thirds-one third systems of share tenancy practiced in Tayabas and Laguna do not differ very much as far as advantages for either landlord or tenant is concerned.

7. There is great opportunity for co-operative marketing associations among the coconut farmers in Tayabas and Laguna. There is enough business for at least one association in each of the towns visited in this survey. Through co-operation these farmers would eventually be able to export their produce direct to foreign markets. Everything points favorably to the feasibility of the establishment of co-operative marketing associations in these two provinces. All the farmers have the same problems to face; they are raising a product destined for foreign markets; they need regulations and instructions which they will approve to govern them in their activities in order to improve their production and make the marketing of their produce easy, cheap, and efficient.

8. It was found that the quantity of desiccated coconut manufactured from 1,000 nuts varies according to the size and thickness of the coconut meat and also the capacity and efficiency of the mill. The larger the coconuts and the thicker the meat, the greater the quantity of desiccated coconut product obtained from them. Also, the larger the capacity of the mill and the greater its efficiency the less waste there is in the manufacture of the product and therefore the more desiccated coconut obtained from 1,000 nuts. The amount of desiccated coconut obtained from 1,000 nuts ranges from 280 to 390 pounds, according to data from four of the six desiccated coconut factories in Tayabas and Laguna. The cost of production ranges from ₱0.06 to ₱0.106 a pound, all items of cost included, except fixed charges.

TABLE 1

Showing quantity of nuts transported by railroad from January 1 to March 31, 1930

STATIONS	JANUARY		FEBRUARY		MARCH		TOTAL	
	Num. of	Freight	Num. of	Freight	Num. of	Freight	Num. of	Freight
	nuts	*pesos*	*nuts*	*pesos*	*nuts*	*pesos*	*nuts*	*pesos*
San Pablo	117,710	227.36	292,127	324.86	47,169	31.67	457,006	583.89
Santa Ana	88,590	160.80	140,500	123.03	53,380	24.36	282,470	308.19
Tiaon	None	——	13,097	16.17	105,460	129.36	118,557	145.53
Lusacan	15,592	33.81	None	——	None	——	15,592	33.81
Candelaria	37,900	87.57	337,950	642.18	442,824	624.07	818,674	1,353.82
Lutucan	696,191	1,579.23	636,502	1,298.69	511,206	1,047.48	1,843,899	3,925.40
Bucal	141,000	337.26	168,580	380.94	121,200	215.59	430,780	933.79
Total	1,096,983	2,426.03	1,588,756	2,785.87	1,281,239	2,072.53	3,966,978	7,284.43

TABLE 2

Showing quantity of copra shipped by railroad from January 1 to March 31, 1930

STATIONS	JANUARY		FEBRUARY		MARCH		TOTAL	
	Weight	Freight	Weight	Freight	Weight	Freight	Weight	Freight
	kgm.	*pesos*	*kgm.*	*pesos*	*kgm.*	*pesos*	*kgm.*	*pesos*
San Pablo	348,000	1,582.88	159,000	693.12	113,051	484.15	620,050	2,759.95
Santa Ana	17,594	119.90	14,476	97.97	3,402	20.09	35,373	237.96
Tiaon	33,355	179.18	105,000	553.35	41,000	187.60	179,355	919.60
Lusacan	19,240	105.36	47,982	259.70	35,192	176.95	102,414	542.01
Candelaria	297,644	1,724.55	350,902	2,006.55	158,266	799.57	806,812	4,531.02
Lutucan	357,597	1,902.38	328,761	2,025.80	185,764	1,046.63	872,122	4,974.81
Bucal	313,110	1,969.89	314,115	1,936.49	180,105	1,051.86	807,330	4,958.24
Total	1,386,540	7,584.14	1,320,136	7,573.33	716,780	3,766.32	3,423,456	18,923.59

TABLE 3

Showing a comparison of the cost of production of copra in Tayabas and Laguna: computed on the basis of 1,000 nuts

ITEMS	COSTS, BASED ON 1,000 NUTS	
	Tayabas	Laguna
Cost of making copra from 1,000 nuts	₱ 4.00	₱ 4.00
Tax on one-half hectare of land assessed as second class at ₱105 a hectare; rate of taxation being 87½ centavos for every ₱100, computed on the basis of 4 harvests a year, or one-fourth of ₱0.46	0.115	0.115
Tax on 100 trees assessed as second class at ₱4.50 a tree; rate of taxation being 87½ centavos for every ₱100, computed on the basis of 4 harvests a year, or one-fourth of ₱3.94	0.98	0.98
Interest on capital invested in 100 trees at ₱5 a tree; rate of interest being 6 per cent per annum and computed on the basis of 4 harvests a year, or one-fourth of ₱30.00	7.50	7.50
Upkeep of 100 trees at 10 centavos a tree a year; computed on the basis of 4 harvests a year, or one-fourth of ₱10.00	2.50	2.50
Depreciation on the *tapahan* (₱30) at 10 per cent per annum and computed on the basis of 4 harvests a year, or one-fourth of ₱3	0.75	0.75
Total marketing cost borne by the farmer (38 centavos per picul in Laguna and 53 centavos per picul in Tayabas); computed on the basis of 4 piculs in Tayabas and 3.5 piculs in Laguna for every 1,000 nuts	2.12	1.33
Total	₱17.965	₱17.175
Cost per picul of copra, computed on the basis of 4 piculs in Tayabas and 3.5 piculs in Laguna for every 1,000 nuts	₱ 4.491	₱ 4.907

TABLE 4

Showing a comparison of cost of production of nuts, based on 1,000 nuts, in Tayabas and Laguna

ITEMS	COST PER 1,000 NUTS	
	Tayabas	Laguna
Cost of picking, piling, husking, and hauling to buyer's place of assembling his purchases	₱ 3.75	₱ 3.45
Tax on one-half hectare of land assessed as second class at ₱105 a hectare; rate of taxation being 87½ centavos for every ₱100, computed on the basis of 4 harvests a year, or one-fourth of ₱0.46	0.115	0.115
Tax on 100 trees assessed as second class at ₱4.50 a tree; rate of taxation being 87½ centavos for every ₱100; computed on the basis of 4 harvests a year, or one-fourth of ₱3.94	0.98	0.98
Interest on capital invested on 100 trees at ₱5 a tree; rate of interest being 6 per cent per annum, computed on the basis of 4 harvests a year, or one-fourth of ₱30	7.50	7.50
Upkeep of 100 trees at 10 centavos a tree a year, computed on the basis of 4 harvests a year, or one-fourth of ₱10	2.50	2.50
Total	₱14.845	₱14.545

TABLE 5

Showing cost of production of a pound of desiccated coconut in Tayabas and Laguna

FACTORY	MAXIMUM DAILY CAPACITY	AVERAGE DAILY CAPACITY	YIELD IN DESICCATED COCONUT OF AVERAGE DAILY CAPACITY	YIELD IN DESICCATED COCONUT FOR EVERY 1,000 NUTS	NUMBER OF CASES OF DESICCATED COCONUT OF 140 POUNDS EACH PRODUCED FROM THE AVERAGE DAILY CAPACITY	ESTIMATED COST PER POUND OF DESICCATED COCONUT [a]
	nuts	*nuts*	*pounds*	*pounds*	*cases*	
A.	180,000	137,000	57,539	390.72	425.28	₱ 0.06
B.	75,000	55,000	16,940	308.00	121.00	0.102
C.	70,000	45,000	12,600	280.00	90.00	0.106
D.	65,000	46,000	13,400	291.30	96.00	0.104

[a] This estimated cost of production per pound includes all items of cost, except fixed charges, such as depreciation on machinery and buildings, and interest on investment. It is based on the information furnished which claims that it costs ₱0.11 to produce a pound of desiccated coconut when the mill grinds 25,000 nuts and ₱0.09 per pound when the mill grinds 60,000 nuts daily.

TABLE 6

Showing expenditure and income of a proprietor-farmer from one hectare on which are 200 trees each yielding 40 nuts a year

ITEMS	TAYABAS		LAGUNA	
	Copra	Nuts	Copra	Nuts
	pesos	*pesos*	*pesos*	*pesos*
Cost of gathering and marketing 8,000 nuts at ₱3.75 for 1,000 in Tayabas and ₱3.45 in Laguna, or making a copra from the nuts at the rate of 4 piculs per 1,000 at a cost of ₱1.12 a picul in Tayabas, and 3.5 piculs per 1,000 at a cost of ₱1.40 in Laguna.	35.84	30.00	39.20	27.60
Tax on one hectare of land assessed as second class at ₱105; rate of taxation being 87½ centavos for every ₱100.	0.92	0.92	0.92	0.92
Tax on 200 trees assessed as second class at ₱4.50 a tree; rate of taxation being 87½ centavos for every ₱100.	7.88	7.88	7.88	7.88
Interest on capital invested in 200 trees at ₱5 a tree; rate of interest being 6 per cent per annum.	60.00	60.00	60.00	60.00
Yearly upkeep of 200 trees at 10 centavos a tree. . .	20.00	20.00	20.00	20.00
Depreciation on *tapahan* (₱30) at the rate of 10 per cent per annum.	3.00	——	3.00	——
Total expenditure per hectare.	127.64	118.80	131.00	116.40
Gross income from one hectare (8,000 nuts) when ₱30 per 1,000 is the market price of nuts; or 32 piculs of copra under Tayabas conditions selling at ₱8.40 a picul, and 28 piculs under Laguna conditions selling at ₱8.00 a picul.	268.80	240.00	224.00	240.00
Net income per hectare.	141.16	121.20	93.00	123.60

TABLE 7

Showing landlord's expenditure and income from one hectare of coconut plantation on which are 200 trees each yielding 40 nuts a year, the plantation being taken care of by tenants employed under either of the two systems of share tenancy

	3/4–1/4 SHARE BASIS				2/3–1/3 SHARE BASIS			
	Tayabas		Laguna		Tayabas		Laguna	
	Copra	Nuts	Copra	Nuts	Copra	Nuts	Copra	Nuts
	pesos	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*
Tax on one hectare of land assessed as second class at ₱105; rate of taxation being 87½ centavos for every ₱100	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Tax on 200 trees assessed as second class at ₱4.50 each; rate of taxation being 87½ centavos for every ₱100	7.88	7.88	7.88	7.88	7.88	7.88	7.88	7.88
Interest on capital invested in 200 trees at ₱5 a tree; rate of interest being 6 per cent per annum	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00
Depreciation on the *tapahan* (₱30) at the rate of 10 per cent per annum	3.00	—	3.00	—	3.00	—	3.00	—
Landlord's share of expense of preparing product for market	26.88	22.50	29.40	20.70	—	—	—	—
Total cost per hectare	98.68	91.30	101.20	89.50	71.80	68.80	71.80	68.80
Gross income from 8,000 nuts, their yield in copra of 32 piculs under Tayabas conditions and 28 piculs under Laguna conditions, when the market price of nuts is ₱30 per 1,000, and that of copra ₱8.40 a picul in Tayabas and ₱8.00 in Laguna	201.60	180.00	168.00	180.00	179.20	160.00	149.33	160.00
Net income per hectare	102.92	88.70	66.80	90.50	107.40	91.20	77.53	91.20

TABLE 8

Showing expenditure and income of a tenant from one hectare of coconut plantation on which are 200 trees each yielding 40 nuts a year when the tenant works under each of the two systems of share tenancy practiced in Tayabas and Laguna

ITEMS	3/4–1/4 SHARE BASIS				2/3–1/3 SHARE BASIS			
	Tayabas		Laguna		Tayabas		Laguna	
	Copra	Nuts	Copra	Nuts	Copra	Nuts	Copra	Nuts
	pesos	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*
Tenant's share of the cost of preparing and marketing 8,000 nuts, or their yield in copra under Tayabas and Laguna conditions	8.96	7.50	9.80	6.90	35.84	30.00	39.20	27.60
Yearly upkeep of 200 trees at 10 centavos a tree	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Total expenditure per hectare	28.96	27.50	29.80	26.90	55.84	50.00	59.20	47.60
Gross income from 8,000 nuts when ₱30 per 1,000 is the market price of nuts; or 32 piculs of copra under Tayabas conditions sells at ₱8.40 a picul, and 28 piculs under Laguna conditions sells at ₱8.00 a picul	67.20	60.00	56.00	60.00	89.60	80.00	74.67	80.00
Net income per hectare	38.24	32.50	26.20	33.10	33.76	30.00	15.47	32.40

A PRELIMINARY STUDY OF THE GLUCOSE, SUCROSE, AND REFRACTOMETER SOLIDS RELATIONSHIPS OF FIVE SUGAR CANE VARIETIES GROWN UNDER LAGUNA CONDITIONS[1]

MANUEL L. HOLLERO

WITH FOUR GRAPHS

Cane sugar factory managers as well as sugar cane planters are primarily interested in the sugar content of the canes. The glucose, sucrose, and refractometer solids are the constituents in the cane juice with which sugar producers are concerned. A study on the relationships of these different constituents in some varieties of cane will give an idea of how these three substances vary.

No attempt has been made by previous investigators to find out if there exists a constant figure in the glucose-sucrose ratio in similar joints of the different varieties studied at approximately the same age. The project here reported was conducted for the purpose of investigating these relationships and establishing, if possible, a sucrose-glucose ratio so as to obtain an index of maturity.

REVIEW OF LITERATURE

Alexander (1926) showed that at a certain period in the growth of cane there exists a minimum percentage of glucose and at about this period one gets the maximum purity. He pointed out that with the analysis of the sugar content of the cane, one can easily tell when and what field should be milled first so as to get as much sugar from it as possible.

Viswanath and Ayyar (1924) state that, as a cane ripens, the various internodes show a leveling tendency in their total solid content. Also that the purity alone is not always a reliable criterion for judging the maturity of a cane crop. They further state that ratio of top Brix to bottom Brix is convenient and accurate in testing the stage of maturity of a cane.

OBJECTS OF THE PRESENT WORK

This investigation was undertaken to determine: (*a*) if a certain quantitative relationship exists between the sugars and solids in the different internodes and the purity, or quality of the juice therein; (*b*) to determine if the glucose and sucrose percentages found in one variety will be found in another variety; and (*c*) to investigate the variations in the solid material by internodes for the five varieties.

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[1] Thesis presented for graduation, 1930, from the College of Agriculture, with the degree of Bachelor of Science in Sugar Technology, No. 317; Experiment Station contribution No. 674. Prepared in the Department of Agricultural Chemistry under the direction of Professor Reginald H. King.

TIME AND PLACE OF THE PRESENT WORK

The work was started November 5, 1928, and was finished in June, 1929. The work was done in the laboratory of the U. P. Sugar Mill at the College of Agriculture.

MATERIALS AND METHODS

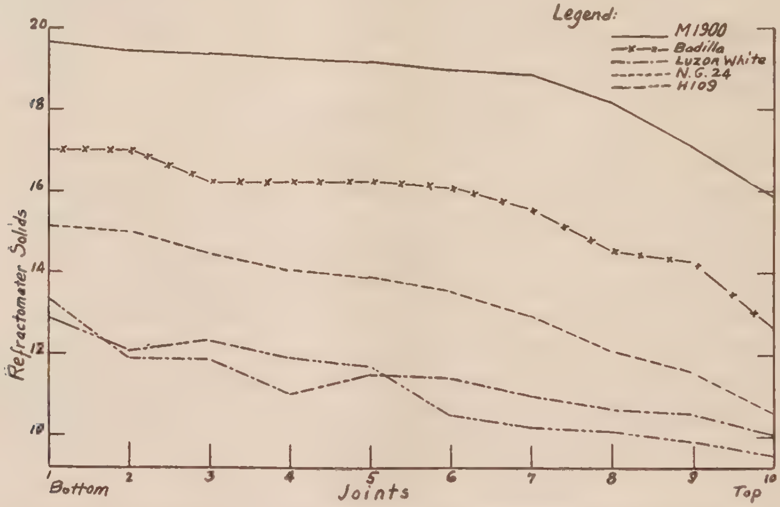
Sources of materials

Sugar canes planted by the College were used. Five varieties were analyzed, that is, H-109, Luzon White, Badila, New Guinea 24, and Mauritius 1900. The canes were eleven and a half months old.

In order to get a uniform sample as to age and length of internodes, the canes for analysis were gathered from different stools of each variety. Ten stalks were cut from each variety for analysis.

Preparation of samples for analysis

The sampling was done by cutting off the tops of the canes, or those portions which are generally utilized for points, including the leaves. This portion was discarded. Then from the bottom of what was left of the stalks, ten internodes were cut, including their basal nodes, towards the top. The ten groups of internodes, with their basal nodes, constituted the ten samples for the analysis. Each group was ground separately in a hand mill and the extracted juices were separately analyzed.



Graph 1.—Showing the relationship between refractometer solids and joints.

The sucrose content of the samples must be known in order to evaluate the reducing sugars. For ordinary test on juices, the difference between sucrose and polarization may be neglected. Directions given under preparation of samples on page 40, *Methods of Chemical Control* by the Hawaiian Chemists' Association (1923) were followed, except that the amount of samples and the dilution were varied to suit the requirements of this test. McAllep (1926) specified that the sucrose concentration in the sample prepared for analysis should not exceed 5 grams per 100 cc., preferably the glucose concentration should be such that 25-40 cc. of the solution corresponding to 125 to 200 milligrams of glucose per 100 cc., are required for the titration.

Solutions of the juice from different internodes were prepared according to the method given in *Methods of Chemical Control.*

Methods used

Glucose was determined by the methylene blue method (McAllep, 1926).

Standard invert sugar solution was prepared by dissolving 9.5 grams of the demicube sugar in 5 cc. of concentrated hydrochloric acid and adding water to make up a volume of approximately 100 cc. The solution was allowed to stand for three days, then was made up to the volume of one liter.

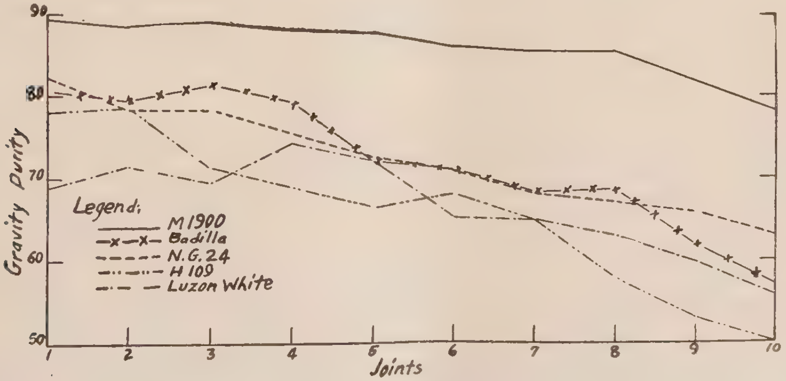
Sucrose was determined by Walker's Inversion Method (Anonymous, 1923, p. 39.) The method calls for a double polarization of the juice. Thus two readings were obtained—a direct reading and an invert reading. The sucrose reading in the juice was obtained by the formula:

$$\text{Sucrose reading in juice} = \frac{100\ (D - 4/3\ I)}{142.4 - .5T}$$

Whence D = the direct reading, I = the invert reading, T = the temperature of the invert reading, 142.4 = the factor for mixed juice and 4/3 = the factor used when 75 cc. of the filtrate was used for inversion.

EXPERIMENTAL RESULTS

To minimize the personal equation, several determinations were made to get an average for the tables. Hence, the data presented in this paper are averages.



Graph 2.—Showing the relationship between gravity purity and joints.

Table 1 shows the variation in percentage of sucrose and gravity purity among the five varieties of sugar cane.

The variations in percentage of glucose and glucose per 100 refractometer solids among the five varieties studied are shown in table 2.

Table 3 gives the variations in the glucose sucrose ratio.

Variations in the refractometer solids content are found in table 4.

Table 5 shows the per cent total solids by internodes.

Graphs 1 and 2 show the comparative graphs of the refractometer solids and gravity purity by internodes.

Graphs 3 and 4 represent the relationship that exists between the per cent glucose and glucose per 100 refractometer solids. A similar relationship, as is found in graph 1, exists between these two substances.

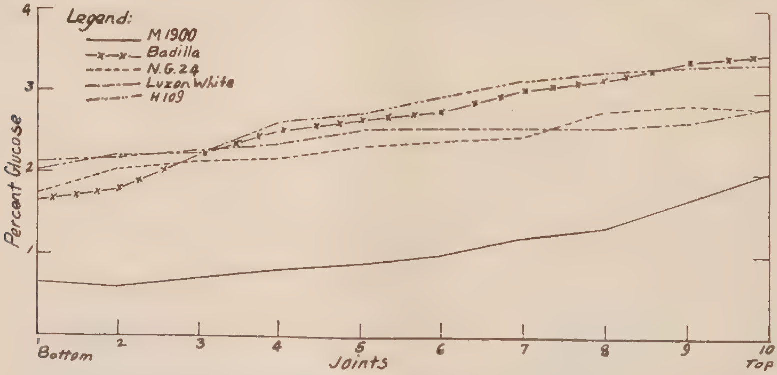
DISCUSSION OF RESULTS

From table 1 it may be seen that the sucrose content as well as the gravity purity decreases with stalk elongation towards the top. The glucose and sucrose per 100 refractometer solids increase with stalk elongation and the less mature internodes contain less sucrose and more glucose than the older ones.

The glucose sucrose ratio was found to vary in general in all varieties as well as in the different internodes analyzed. No figure was found to be constant for all varieties.

It was also observed that the refractometer solids decrease from bottom to top. The behavior of the three substances in the cane stalks points to some physiological change that takes place in the cane as it matures.

The total amount of sugars, that is, glucose and sucrose per 100 refractometer solids is not constant in a given variety. Nor is the total sugars per 100 refractometer solids the same for each internode of all varieties. The analysis of Hawaii-109 showed for the bottom internode a total sugars of 93.61, for the second internode 97.57, and for the very top 86.77. Luzon White had a total sugar content at the bottom internode



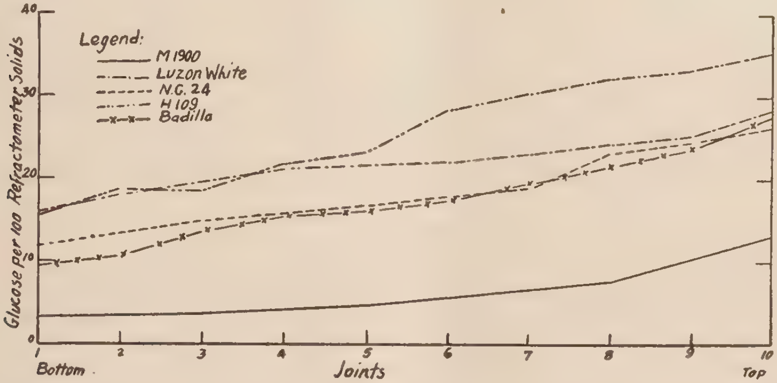
Graph 3.—Showing the relationship between percentage of glucose and joints.

of 85.4 and at the top internode of 84.85. The differences in total sugars from top to bottom was 6.84 for Hawaii-109; 0.55 for Luzon White; 5.77 for Badila; 3.62 for New Guinea 24, and 0.92 for Mauritius 1900.

This wide variation shows that varieties are capable of differing in their total sugar content regardless of the purity of the juice.

That the refractometer solids have some bearing on the gravity purity of the cane juices is seen in graph 1. For a drop in gravity purity there is also a drop in refractometer solids. This statement may be applied generally for all the varieties studied.

Graph 2 shows that as the top portion of the stalk was reached there was an increase in the percentage glucose and also in the glucose per 100 refractometer solids.



Graph 4.—Showing the relationship between glucose per 100 refractometer solids and joints.

SUMMARY AND CONCLUSIONS

1. The percentage sucrose shows a considerable variation among the internodes and in the different varieties analyzed.
2. The refractometer solids in a cane are related to the gravity purity, that is, the higher the refractometer solids the greater the gravity purity.
3. The amount of glucose in a particular part of one cane is not the same as in that part of another cane.
4. The glucose-sucrose ratio varies with the number of joints.
5. The glucose-sucrose ratio is not constant in all varieties.

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TABLE 1

Variations in percentage of sucrose and gravity purity in the five varieties

INTERNODES	VARIETIES									
	Hawaii—109		Luzon White		Badila		New Guinea—24		Mauritius—1900	
	Sucrose	Refractometer purity	Sucrose	Refractometer purity	Sucrose	Refractometer purity	Sucrose	Refractometer purity	Sucrose	Refractometer purity
	per cent		*per cent*		*per cent*		*per cent*		*per cent*	
Bottom	10.11	78.01	9.23	69.50	13.83	81.16	12.54	82.61	17.67	89.70
2	9.50	78.77	8.57	71.54	13.48	79.11	11.85	78.58	17.27	88.56
3	8.78	71.03	8.27	69.61	13.26	81.65	11.40	78.93	17.29	89.12
4	8.22	69.07	8.24	74.37	12.85	79.13	10.66	75.71	17.10	88.37
5	7.84	66.67	8.37	72.28	11.71	72.11	10.19	72.89	16.94	88.23
6	7.12	68.07	7.47	65.07	11.43	71.26	9.87	71.21	16.38	86.21
7	6.68	65.11	7.21	65.07	10.64	68.47	8.87	68.34	16.21	85.77
8	5.91	58.16	6.82	63.86	10.02	68.91	8.15	67.47	15.62	85.82
9	5.33	53.51	6.35	60.01	9.00	62.20	7.62	66.09	14.11	81.74
Top	4.85	51.37	5.68	56.35	7.21	57.49	6.75	63.79	12.61	78.98

TABLE 2

Variations in percentage glucose and glucose per 100 refractometer solids in the five varieties

INTERNODES	VARIETIES									
	Hawaii—109		Luzon White		Badila		New Guinea—24		Mauritius—1900	
	Glucose	Glucose per R.S.	Glucose	Glucose per R.S.	Glucose	Glucose per R.S.	Glucose	Glucose per R.S.	Glucose	Glucose per R S.
	per cent		*per cent*		*per cent*		*per cent*		*per cent*	
Bottom	2.02	15.6	2.11	15.9	1.66	9.7	1.77	11.7	0.651	3.2
2	2.27	18.8	2.19	18.3	1.79	10.5	2.01	13.3	0.623	3.3
3	2.59	18.5	2.29	19.3	2.22	13.7	2.15	14.8	0.719	3.7
4	2.62	21.9	2.34	21.1	2.51	15.5	2.19	15.6	0.839	4.3
5	2.74	23.3	2.53	21.8	2.66	16.3	2.33	16.7	0.911	4.7
6	2.96	28.3	2.53	22.0	2.78	17.3	2.40	17.7	1.080	5.7
7	3.11	30.3	2.55	23.0	3.04	19.6	2.47	19.0	1.250	6.6
8	3.26	32.1	2.58	24.2	3.13	21.5	2.79	23.1	1.380	7.6
9	3.31	33.2	2.67	25.2	3.36	23.6	2.83	24.5	1.740	10.2
Top	3.35	35.4	2 87	28.5	3.46	27.6	2.85	26.9	2.060	13.0

TABLE 3

Variations in glucose-sucrose ratio among the five varieties

JOINTS	VARIETIES				
	Hawaii 109	Luzon White	Badila	New Guinea–24	Mauritius 1900
Bottom	.199	.229	.120	.141	.037
2	.239	.256	.135	.169	.036
3	.261	.277	.168	.189	.042
4	.319	.284	.195	.205	.049
5	.349	.302	.227	.229	.054
6	.416	.339	.243	.248	.066
7	.466	.358	.286	.278	.077
8	.552	.378	.312	.342	.088
9	.621	.420	.373	.371	.123
Top	.689	.505	.479	.422	.163

TABLE 4

Refractometer solids variations in the different varieties

JOINTS	VARIETIES				
	Hawaii 109	Luzon White	Badila	New Guinea–24	Mauritius 1900
Bottom	12.96	13.28	17.04	15.18	19.7
2	12.06	11.98	17.04	15.08	19.5
3	12.36	11.88	16.24	14.48	19.4
4	11.96	11.08	16.24	14.08	19.3
5	11.76	11.58	16.24	13.98	19.2
6	10.46	11.48	16.04	13.58	19.0
7	10.26	11.08	15.54	12.98	18.9
8	10.16	10.68	14.54	12.08	18.2
9	9.96	10.58	14.24	11.58	17.1
Top	9.46	10.08	12.54	10.58	15.8

TABLE 5

Percentage total sugars per 100 refractometer solids by joints

JOINTS	VARIETIES				
	Hawaii 109	Luzon White	Badila	New Guinea–24	Mauritius 1900
Bottom	93.61	85.40	90.86	94.31	92.90
2	97.57	89.84	89.61	91.88	91.86
3	89.53	88.91	95.35	93.53	92.82
4	90.97	95.47	94.63	91.31	92.67
5	89.97	94.08	88.41	89.59	92.93
6	96.37	87.07	88.56	88.91	91.91
7	95.41	88.07	88.07	87.34	92.37
8	90.26	88.06	90.41	90.57	93.42
9	86.71	85.21	85.80	90.59	91.94
Top	86.77	84.85	85.09	90.69	91.98

BIOLOGY OF VIVIPARA ANGULARIS MÜLLER, A COMMON FRESH-WATER SNAIL IN LAGUNA DE BAY[1]

FIDEL H. ALONTE

WITH ONE PLATE, TWO TEXT FIGURES, AND ONE CHART

INTRODUCTION

The conditions obtaining in Laguna de Bay and its tributaries appear to be favorable for the proper development and multiplication of fresh-water snails and other bottom-crawling and clinging types of animals characteristic of shallow fresh-water lakes and streams. This is the reason that in these bodies of water there are found in great abundance species of snails, among which may be mentioned the following:

Vivipara angularis Müller (Viviparidae)
Ampullaria luzonica Reeve (Ampullariidae)
Melania lateritia Lea (Melaniidae)
Melania scrabra Müller (Melaniidae)
Melania pantherina Von dem Busch (Melaniidae)
Melania asperata Lamarck (Melaniidae)
Melania blatta Lea (Melaniidae)
Amphipeplea luzonica Beck (Lymnaeidae)
Planorbis philippinarum Dunker (Lymnaeidae)

Because of the prevalence of these snails, they play an important rôle in the economic life of the inhabitants of the provinces bordering Laguna de Bay. Of these species, *Vivipara angularis*, locally known as *susong pangpang* (Tagalog), is the most valued by duck raisers. At times of scarcity of this species of snail, duck raisers resort to feeding their birds with *Corbicula manillensis* (*tulla*), and *Melania lateritia* and *M. pantherina* (*susong buele*). *V. angularis* is to some extent utilized also as food by the inhabitants of Laguna Province.

The snail is also extensively used as bait on *kitang* (set lines, Tagalog) in Laguna de Bay. This fishing gear catches *kanduli* in commercial quantities. The snails rank second in importance as natural food of the *kanduli* (Mane, 1929).

It has been observed that *Gallinula chloropus* L. (*ulok*, Tagalog) and *Nycticorax nycticorax* L., (*bakaw pulo*, Tagalog) feed on *A. luzonica* and

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[1] Thesis presented for graduation, 1930, from the College of Agriculture, with the degree of Bachelor of Agriculture, No. 675; Experiment Station contribution No. 318. Prepared in the Department of Entomology under the direction of Assistant Professor Deogracias V. Villadolid.

V. angularis in places where water hyacinths are abundant. The birds make holes in the largest whorl of the snail and through these openings the animals inside the shells are drawn out. These birds apparently prefer *A. luzonica* to *V. angularis*, as more empty and broken shells of the former are found in places where these birds have been seen to feed.

Time and place of the present work

The work here reported was begun in April, 1929, and closed in March, 1930. For the most part, observations and collection of samples were made in Mayondon, Los Baños. Trips were made to different towns along the shores of Laguna de Bay for the purpose of securing information regarding the habits of the snails and to observe places where they were found in abundance.

Laboratory studies were carried on at Mayondon in the Los Baños Limnological Station of the Department of Entomology.

Objects of the present work

The objects of the present work were: (*a*) To follow the development of the ova up to the time the young are born; (*b*) to determine the rate of growth of the snail; (*c*) to observe the reproductive habits of the snail; (*d*) to determine the size and age at sexual maturity; (*e*) to make observations on the relative abundance of snails in the lake; and (*f*) to observe the feeding habits of the snails.

MATERIALS AND METHODS

Field studies

Collection of materials. The collecting of materials for study was done largely in Mayondon and in neighboring places in Los Baños. Collecting was also done in different parts of Laguna de Bay where snails could be found in abundance. The snails stored by duck raisers to be fed to ducks were likewise examined and samples taken.

Study on the relative abundance of snails in Laguna de Bay. From time to time trips were made in different portions of Laguna de Bay and duck-raising centers bordering the lake. Observations were made and information gathered on the relative abundance of snails in different parts of Laguna de Bay.

Observation on feeding habits. The water in the lake included in the reservation of the Los Baños Limnological Station is always quiet and clear so that the feeding habits of the snails in their natural habitat could be observed without difficulty (fig. 1). The snails were closely watched while in the act of feeding and their food examined. Observations were also made on the feeding habits of the snails reared in aquaria.

Examination of the stomach contents was not resorted to in this study because the snails eat small particles of food, which become triturated beyond recognition by the radula (plate 1, fig. 12).

Laboratory studies

Study on the development of the ova. In this study, the gonads of the snails were examined and the condition of the ova determined from the earliest recognizable formation of eggs up to the stage of the birth of young snails. The length of time that it takes from one stage of development to another was determined.

Studies on the rate of growth. One-day old snails were reared in aquaria in the laboratory and in bamboo baskets near the shore of the Limnological Station. The snails were measured from time to time. The measurements were made by means of a micrometer caliper graduated to 0.01 millimeter. The length of the snail was determined by taking the distance from the apex to the basal edge of the lip, measured along a line drawn through the axis.

Fig. 1.—A habitat group in the reservation of the College Limnological Station at Mayondon where observations on the feeding habits of *Vivipara angularis* Müller were carried on. Note the quiet and clear water.

Determination of size at sexual maturity. Fresh materials representing different sizes were collected from the lake and examined from time to time. The smallest mature snails were isolated and measured with the caliper and the condition of the ovotestis examined under a compound microscope. The presence of mature ova was used as criterion for sexual maturity.

RESULTS AND DISCUSSIONS

Vivipara angularis is a hermaphrodite. The reproductive system consists of a hermaphroditic gland, or ovotestis, which is a yellowish, bean-shaped body embedded in the liver and forming part of its spiral but not reaching the apex. Within this gland are developed the ova and the spermatozoa. The two kinds of germ cells are produced side by side. The albumen gland is a large linguiform mass of tissues. The hermaphroditic duct is more or less convoluted. It is enlarged anteriorly and is partially divided by a kind of septum into male and female portions. At their anterior ends, the two portions of the duct separate completely into an oviduct and a vas deferens. The oviduct widens into the vagina which is furnished with a pair of mucus glands. Below the mucus glands is a sac, called dart sac, containing calcareous spicules. The vagina opens into the pallial cavity. The vas deferens is tubular, retractile, and lies across the oesophagus.

Development of the ova

About one thousand adult snails were collected on September 10, 1929, and placed overnight in a large basin containing fresh water. During the night about 250 young snails were born. These were gathered and reared in small baskets in the Limnological Station where the water was quiet. The bottoms of the baskets were stuck deep in the mud so that organic materials and microscopic organisms which serve as food for the snails could pass through the bottoms of the baskets.

The immature ova. Dissection was not begun until October 22, when the snails had reached an average length of 16.9 millimeters, which was found in the present work to be the size at which this species attains sexual maturity. After this date, dissections of five snails were made at intervals of two days to ascertain the condition of the gonad. When the ovotestis was about to develop, dissections were made daily. A small portion of the ovotestis was teased out on a slide and the examination of the ova made.

On November 5, small ova (pl. 1, fig. 3) measuring from 0.009 to 0.018 millimeter in diameter were seen differentiating from the acini of the ovotestis. The ova were transparent, with greenish black chromatophores.

At this time, mature sperms were seen actively swimming. There were two types of spermatozoa found; namely, the hair-like, or filiform, and the worm-like or vermiform (pl. 1, fig. 10 and 11). The first type is elongated with a pointed anterior end. A short distance from this end, the spermatozoa form four to five coils and then become straight again posteriorly. They measure from 40 to 50 μ in length and from 2 to 3 μ in diameter. The vermiform spermatozoa are likewise elongated, tapering a little posteriorly. At the anterior end it bears a tuft of six flagella. These spermatozoa measure from 81 to 85 μ in length and from 4 to 6 μ in diameter.

Shipley and Reed (1895) mention the occurrence in *Paludina, Ampullaria,* and certain species of *Murex,* of two types of spermatozoa, one hair-like and the other worm-like. They suggest that the worm-like spermatozoa are a kind of incipient ova, and indicate a possible transitional stage in hermaphroditism.

According to Lankester (1906), in some Taenioglossa, such as *Paludina* and *Pteroceras*, and in several Stenoglossa, such as *Murex*, *Nassa*, *Purpura*, etc., there are two kinds of spermatozoa, the one normal and filiform, the other vermiform; the function of the latter kind is not yet explained. In *Paludina*, for example, these two kinds of spermatozoa exist in equal quantities, but the filiform kind, with a single cilium, originates from the spermatids which have increased but little in size during the growth period, and contain the normal quantity of nuclear substance; these are the eupyrenic spermatozoa of Meves. The vermiform spermatozoa, on the other hand, have about six cilia apiece and originate from the spermatids which have increased largely in size during the growth period, and contain only a small quantity of nuclear substance; they are known as oligopyrenic spermatozoa.

Neither detailed studies nor attempts at interpretation were made in the present work in the case of *Vivipara angularis*. The two citations are given here only as of interest in connection with that problem.

Examination of the ovotestis on November 9 showed that some had changed from transparent to opaque, with many light green granules. These ova measured from 5 to 67 μ in diameter.

One week later, on November 16, mature ova (pl. 1, fig. 5 and 6) were seen near the distal portion of the hermaphroditic duct. The widest diameter measured from 1.8 to 2.5 mm. They were ovoid and creamy white. When placed in water they became bluish white, and in dilute formalin solution, opaque.

Condition of the ova after reaching maturity. Fertilized ova were seen in the proximal portion of the oviduct. The fertilized ova bore tiny specks inside the egg membrane. Dissections made from November 17 to 28 showed eggs with embryo of different stages of development. It was noted that as the embryo advanced in development, they were gradually pushed toward the distal portion of the oviduct.

On November 29, it was found that the embryos at the most distal portion of the oviduct were inclosed in membranes.

Dissections made from November 30 to December 11 showed shelled young in different stages of development. The largest young found on December 11 occupied the most distal portion of the oviduct. On December 11, however, one out of the five snails examined had the young in the vagina. The young snails had completely absorbed the yolk.

On December 12, free young were seen for the first time on the sides of the basket. The newly born snails measured from 4.15 to 4.41 mm. in length and from 3.72 to 3.90 mm. in width. The shell consisted of four whorls and varied from yellowish white to brownish violet.

Reproductive habits

Fertilization. When the work on the development of the ova was started on September 10, 1929, five newly born snails were taken and each was reared separately in a small basket near the shore of the Limnological

Station. About three months later, on December 9, 1929, two of the snails gave birth to one young each and the other three each bore one young three days after. From this result, it becomes apparent that the snail is either self-fertilizing or parthenogenetic. Since the ova and the sperms ripen in the same acini in the ovotestis and there is no barrier to insemination in the hermaphroditic duct, there can be no doubt that self-fertilization is the mode of reproduction of this snail. In fact, during the course of the study, no snails were found in the act of copulation. Moreover, it was found upon dissection that the penis is retracted within a sheath below the pallial cavity.

The exact place in the reproductive tract where fertilization takes place has not been definitely ascertained. It was found that ova taken from the proximal portion of the oviduct (near the region where the female and male portions of the reproductive system separate) have tiny embryos showing that they were fertilized in the upper part of reproductive tract.

Self-fertilization in gastropods is not uncommon. Crabb (1928) reports that isolated individuals of *Lymnaea stagnalis appressa* and *Lymnaea palustris* reproduce by self-fertilization. Colton, cited by Crabb (1928), worked on six species of *Lymnaea* and two species of *Planorbis* and arrived at the conclusion that isolated pond snails reproduce by self-fertilization. Nourry (1898), cited by Crabb (1928), arrived at the same conclusion.

The birth of young. The snail is viviparous. Observations showed that when the young snails were discharged from the genital orifice, they were free from egg membrane. These newly hatched snails were motionless for a time (from one to two minutes), but soon they began to open their opercula and crawl on the sides of the containers. Oftentimes they were seen holding fast to the shell of the mother. The mother snail, after giving birth to her young, did not seem to care for them. She continued to crawl and feed actively.

It was observed that when mature snails were dropped into the container, they gave birth to young which were still enclosed in the egg membrane. These aborted young snails were found not to undergo further development. Efforts were made to rear aborted young snails after their egg membranes were ruptured, but they died a few hours after the injury.

Height of fecundity. In an effort to determine the period during which fecundity was at its peak, samples of mature snails were collected at intervals of seven days from June 20, 1929, to February 20, 1930. The number of snails that contained mature eggs and embryos that were developing into young, as well as those without, were counted. The results of this determination are shown in table 1. The peak of multiplication, appeared to have taken place in a period covering October, November, and December, 1929.

Growth of snails

Snails of almost the same age (one-day) were used in the study of growth determination. The absence in *V. angularis* of larval trematodes, as reported by Tubangui (1928), was confirmed in the examination of the snails used in the course of the present work. This fact eliminated one factor, which, if present, might inhibit or retard the rate of growth of the snail.

The young snails used in this study had at first four-whorled shells. Observations were continued until the snails reached the five-whorled stage, which is characteristic of mature individuals. It was found that the snails in lots 1, 2, 3, and 4, which were reared in the laboratory, took from ten to fourteen days to develop the fifth whorl, while those in lots 5 and 6, which were reared in baskets under field conditions, required only from five to seven days.

Lots 1 and 2 were given practically the same amount of food consisting of twigs with algal growth, fine particles of mud with plenty of organic matter, and water hyacinth (*Eichornia crassipes* Solms). *Ceratophyllum demersum* was kept alive in lot 1. The same amount of water was added to both cultures from time to time to replace loss through evaporation. Table 2 shows the growth of snails from August 8 to December 26, 1929.

The rapid growth in lot 1 may be attributed to good aëration brought about by *C. demersum*, as this plant liberates considerable amount of oxygen.

Crabb (1928) working on *Lymnaea stagnalis appressa*, showed that aëration promotes growth, reducing foulness of the medium, by oxydizing decaying substances.

Lots 3 and 4 were run at the same time with lots 1 and 2. Snails in lot 3 were fed with algae growing on twigs and mud with plenty of organic matter; while those in lot 4 received only camote leaves (*Ipomoea batatas* Linn.). In both cultures water hyacinths were grown on top of the water.

The snails in lot 3 grew faster than those in lot 4. (See table 3 and chart 1). At the end of twenty weeks, snails in lot 3 had an average length of 20.57 mm. and an average weekly increment of 0.8 mm. In lot 4, the average size was 16.44 mm. and average weekly increment 0.6 mm. From these results, it appears that the young snails when fed with camote leaves did not grow as much as those fed with decaying vegetable matter which constitutes their characteristic food in their natural habitat.

Lots 5 and 6 were likewise run at the same time, that is, from September 10 to December 24, 1929. The snails were cultured in large, deep bamboo baskets, the bottoms of which were stuck deep in the mud. On the surface of the water in the basket, water hyacinths were grown. Under these conditions, the snails were in almost their own natural habitat.

The results of this experiment, as shown in table 4 and chart 1, proved that these conditions were most favorable for the rapid growth of the snails.

Size and age at sexual maturity

Size at sexual maturity. In determining the size at which the snails attain sexual maturity, a series of dissections of 100 snails in each lot consisting of different size-groups was made at intervals of fourteen days from June 18, 1929, to January 21, 1930. The smallest sexually mature snail was isolated by using the presence of mature ova as criterion for sexual maturity. Table 5 shows the size at sexual maturity of the snails. From this table, it may be seen that snails measuring from 18.1 to 20.7 mm. in length and from 14.3 to 16.7 mm. in diameter, and with an average length 19.09 mm. and average diameter of 15.41 mm. are generally sexually mature.

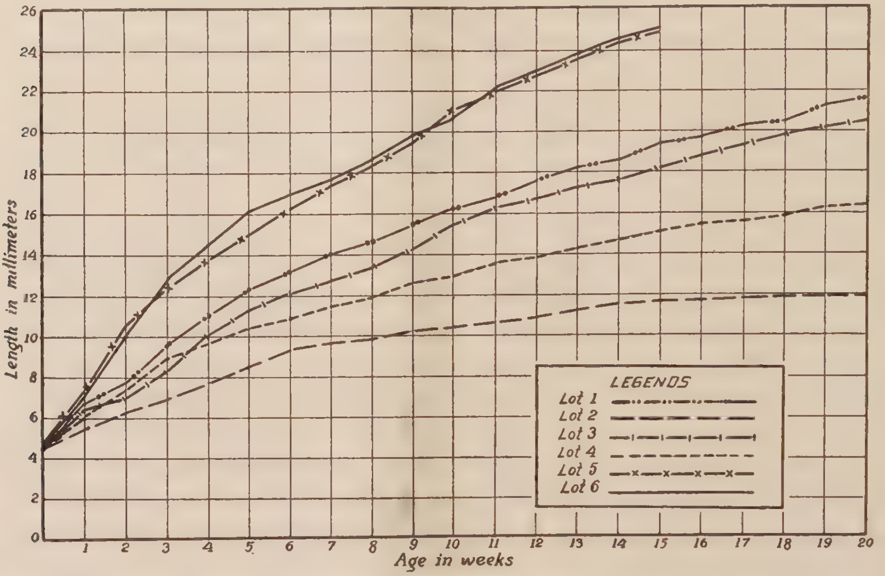

Chart 1.—Showing the rate of growth of *Vivipara angularis* under different conditions.

Lot 1 was cultured under laboratory conditions. The snails were given food consisting of dead twigs with algal growths and fine particles of mud with plenty of organic matter. Water hyacinths were allowed to grow at the surface of the culture.

Lot 2 was given the same conditions as above, except that *Ceratophyllum demersum* was also allowed to grow in the culture.

Lot 3 was given the same conditions as in lot 1, except that no water hyacinths and *C. demersum* were allowed in the culture.

Lot 4 was cultured under laboratory conditions and fed only with camote leaves.

Lot 5 was cultured under field conditions. The snails were reared in a bamboo basket, the bottom of which was stuck deep in the mud.

Lot 6 was cultured the same as lot 5.

Age at sexual maturity. The age at which the snails attain sexual maturity was based on materials used in the determinations of rate of growth. From table 4 it will be noted that the snails measuring 19.73 mm. in length are about 9 weeks or 63 days old. Sexually mature snails collected from their natural habitat in the fields have the same average size as those obtained in the this experiment.

Feeding habits

Observations were made at different places in Mayondon and in the reservation of the Limnological Station where the snails were abundant and the water was usually clear and quiet. With this condition of the water, the snails feeding at the bottom could be seen quite clearly where water was not more than about a meter deep.

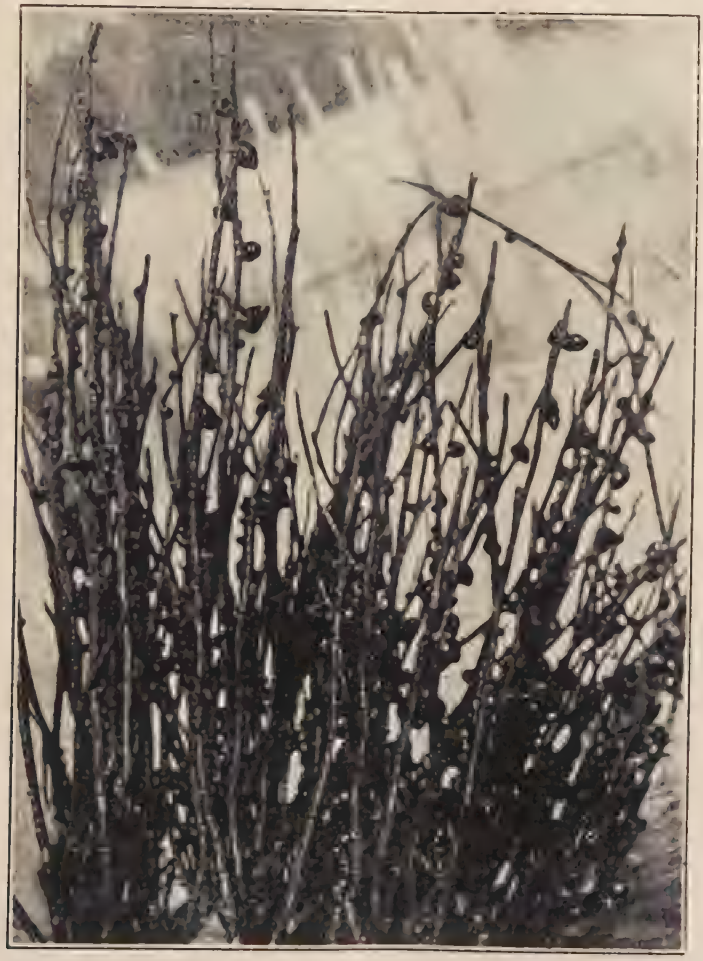

Fig. 2.—*Bonbon*, bundles of twigs immersed in the water for catching shrimps. Algal growths on these twigs serve as food of *Vivipara angularis* Müller.

It was found that the snails are strictly vegetarian. They feed on decaying algae which are commonly found in *bonbon* (fig. 2) (a bundle of dry twigs immersed in the water for catching shrimps), poles, twigs, *baclad*, and stones in the water. The snails were likewise found in abundance on mud on which decaying vegetable or other organic material had settled down from the river beds. This accumulation of organic matter is locally known as *alabuab* (Tagalog).

In the course of observation on growth, young snails were seen feeding on the epidermis of camote leaves; but as the snails became older, they changed their diet to mud and decaying organic matter, as well as algae.

Relative abundance of the snails in Laguna de Bay

From time to time trips were made to the different parts of Laguna de Bay to ascertain the places where the snails were gathered in abundance. The collection of the duck raisers were examined and the places noted where the snails had been gathered.

Place and time of abundance. Observations showed that *V. angularis* was gathered in abundance during the months of October, November, December, 1929, and January, February, and March, 1930. According to experienced duck raisers, this period varies from year to year depending upon the occurrence of floods when the rivers carry large quantities of water into the lake. When there are many floods, the period of abundance of the snail is longer, sometimes extending to the early part of May. From May to September the duck raisers can scarcely get enough *V. angularis* for their ducks, hence they are forced to utilize *M. pantherina* (*susong buele*, Tagalog) and *C. manillensis* (*tulla*, Tagalog) as substitutes.

It was found that during the months of abundance of the snails the duck raisers collected them at almost any place in the lake, but usually in the neighborhood of the duck farms. In time of scarcity they concentrated their collecting efforts around the shores of Talim Island where the snails could be secured in worth while quantities; and frequently duck raisers owning only a few birds gathered their supply of snails along the mouths of streams.

Factors causing scarcity. There are, of course, numerous factors which might influence the abundance or scarcity of the snails.

In the census of 1918 of the Philippine Islands, about 93,973 is given as the number of ducks in the towns of Laguna and Rizal provinces bordering the shores of Laguna de Bay. The duck raisers in these places have no source of snails other than Laguna de Bay. Now it is an accepted fact among the duck raisers that approximately two to three *kaeng*[3] of snails are consumed by 100 ducks in a day. At this rate it would require at least 2,349.3 *kaeng* of snails a day. In a month as much as 70,479.6 *kaeng* would be needed for the maintenance of the ducks in the entire region of the Laguna de Bay. This amount used by duck raisers is indeed enormous and is probably responsible, more than any other factor, for the rapid depletion of snails in Laguna de Bay.

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[3] *Kaeng* is a bamboo basket with a capacity of approximately 50,000 to 60,000 mature snails.

From December to April wild mallards are very numerous on the lake. During this period one may come across flocks of these birds numbering from a few hundreds to more than ten thousand. This large number is a fairly sure indication that snails are abundant in the lake. For like the domesticated ducks, the wild ones feed heavily, if not entirely, on this mollusk.

Polluted water, commonly called *masamang tubig*[4] (Tagalog), spells death to snails. *Melania lateritia* and *M. pantherina* are more hardy and do not succumb so readily. Polluted water occurs generally during the dry season and when the lake is shallow. When a current of foul or polluted water passes over snail beds, only the individuals that manage to sink into the mud survive. Polluted water may be recognized by its color: it may be yellowish, light blue, greenish blue, or greyish white. Often there are bubbles. The odor is decidedly fetid.

One of the principal causes of polluted water is the decay of *lia* (mostly unicellular algae and duckweed, *Lemna paucicostata* Hegelm.), and other unicellular aquatic plants. These are found in the lake from about the close of January to the beginning of the rainy season. During an investigational trip to Calamba Island on February 8, 1930, the writer encountered a flow of polluted water.

Newly caught fishes *ayuñgin* (*Datnia plumbea* Kner, Theraponidae); *kanduli* (Ariidae); *biya* (Gobiidae), and different species of snails were placed in containers with some of this polluted water. After about an hour, the fish were almost dead and were swimming with their snouts above the surface of the water. The young snails died. The next day, or after about 16 hours, all the mature snails were found dead. Samples of this polluted water and ordinary lake water were submitted to Dr. F. T. Adriano of the Department of Agricultural Chemistry for analysis. The results of the analysis follows:

Results are expressed in parts per million

DETERMINATION	POLLUTED WATER	ORDINARY LAKE WATER
Sp. gr. $\frac{26^\circ\text{ C.}}{26^\circ\text{ C.}}$	1.0003	1.0001
Total solids	754.0000	230.0000
Volatile matter	484.0000	60.0000
Fixed residue	270.0000	170.0000
Oxygen consumed	208.0000	16.0000

SUMMARY AND CONCLUSIONS

1. Laguna de Bay has conditions very favorable for the proper development and multiplication of fresh-water snails and other bottom crawl-

ing and clinging types of animals. There are nine species of snails so far recorded in Laguna de Bay and its tributaries. *V. angularis* is the most valued, especially by the duck raisers. It is to some extent used as food by the inhabitants of Laguna and also as bait for *kitang* (set lines).

2. The ova differentiating from the acini of the ovotestis, soon after the maturity of the snail, attain a diameter of from 9 to 18 micra. These ova are whitish transparent with little green chromatophores. At the time these ova are produced, mature sperms are seen actively swimming. The sperms are of two types, the vermiform and the filiform.

3. It takes four days for the transparent ova to change the color to white opaque. The opaque ova measure from 50 to 67 micra in diameter. These ova reach maturity in seven days.

4. Twelve days are required for the eggs to develop shells from the time of fertilization of ova and ten days more before the young are born. The newly born snails measure from 4.15 to 4.41 millimeters and from 3.72 to 3.9 millimeters in width. The shell consists of four whorls which vary from yellowish white to brownish violet.

5. The snails are self-fertilizing, fertilization taking place probably in the acini or the hermaphroditic duct during the passage of the reproductive cells to the oviduct.

6. The newly born snails are free from egg membrane. They remain motionless from one to two minutes after birth, but soon become active.

7. The peak of multiplication of *V. angularis* took place in a period covering October, November, and December, 1929.

8. The snails grew faster in water which was aërated by *Ceratophyllum demersum* than in that which was not.

9. Snails fed with camote (*Ipomoea batatas* L.) leaves grew slower than those fed with algae growing on twigs, organic matter, and mud.

10. The snails reared in their natural habitat grew much faster than those reared in jars in the laboratory.

11. The snails attain sexual maturity at an average length of 19.09 millimeters and an average width of 15.41 millimeters. The average age is 63 days.

12. The snails are almost completely vegetarian; their food consists of decaying algae, decaying vegetable and organic materials, or *alabuab*. In artificial cultures, they were induced to feed while young on camote leaves.

13. In 1929 the snails in Laguna de Bay were most abundant from January to March. The period of abundance varies from year to year depending upon availability of food.

14. Among the factors that tend to deplete the snails in Laguna de Bay the ones deemed most important are: excessive use of snails by duck

raisers; the presence of numerous wild mallards in the lake region; and the periodic occurrence of *masamang tubig*[4] (polluted water) which causes the death of quantities of snails.

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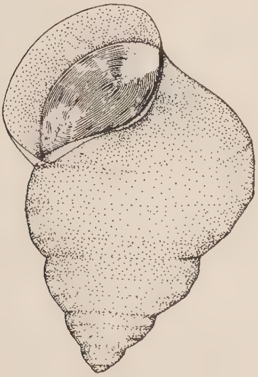
[4] Literally, "bad water".

EXPLANATION OF PLATE I

(*Drawings by Daniel M. Buñag*)

Fig. 1.—*Vivipara angularis* Müller, ×4.
Fig. 2.—*V. angularis*, shell removed, ×2. (Note the embryos and the newly formed shells.)
Fig. 3.—Immature ovum, ×2500.
Fig. 4.—Immature ovum approaching maturity, ×2500.
Fig. 5.—Mature ovum, ×22.
Figs. 6 to 9.—Different stages of the embryonic development of *V. angularis.*
Fig. 10.—Filiform spermatozoa.
Fig. 11.—Vermiform spermatozoon.
Fig. 12.—Radula, ×60.



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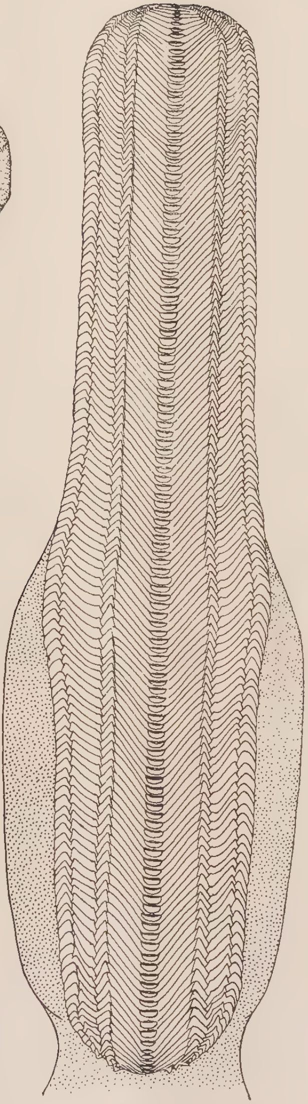

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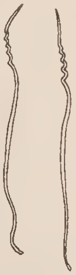

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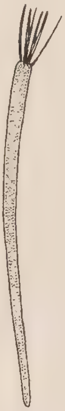

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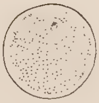

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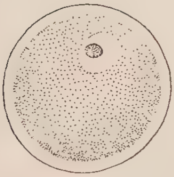

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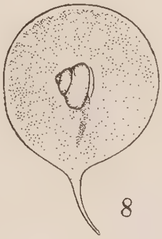

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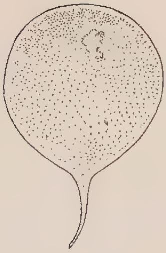

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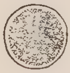

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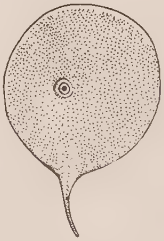

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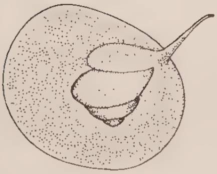

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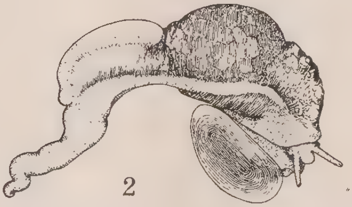

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PLATE 1

TABLE 1

Average monthly percentage of young-bearing Vivipara angularis Müller from samples collected at seven-day intervals from Laguna de Bay

DATE	NUMBER OF SNAILS EXAMINED	NUMBER OF SNAILS WITH YOUNG	PERCENTAGE OF SNAIL WITH YOUNG	AVERAGE PERCENTAGE FOR MONTH
1929				
20–VI	132	66	50.00	51.78
27–VI	140	75	53.57	
4–VII	156	84	53.84	56.10
11–VII	150	84	56.00	
18–VII	142	80	56.34	
25–VII	158	92	58.22	
1–VIII	130	78	60.00	64.42
8–VIII	135	88	65.18	
15–VIII	127	87	68.50	
22–VIII	145	92	63.45	
29–VIII	120	78	65.00	
5–IX	110	80	72.72	77.33
12–IX	138	108	78.26	
19–IX	150	120	80.00	
26–IX	134	105	78.35	
3–X	105	86	81.90	82.54
10–X	112	94	83.92	
17–X	100	83	83.00	
24–X	141	116	82.26	
31–X	120	98	81.66	
7–XI	136	117	86.03	86.45
14–XI	125	109	87.20	
21–XI	150	126	84.00	
28–XI	140	124	88.57	
5–XII	110	94	85.45	84.47
12–XII	122	102	23.60	
19–XII	130	111	85.38	
26–XII	115	96	83.47	
1930				
2–I	125	98	78.40	79.80
9–I	100	83	83.00	
16–I	120	99	82.50	
23–I	118	91	77.11	
30–I	132	103	78.03	
6–II	128	88	68.75	70.04
13–II	120	87	72.50	
20–II	135	93	68.88	

TABLE 2[a]

Average weekly growth of Vivipara angularis

NUMBER OF WEEKS	LOT 1			LOT 2		
	Number of snails measured	Average size	Average growth	Number of snails measured	Average size	Average growth
		mm.	*mm.*		*mm.*	*mm.*
Newly born	10	4.32	——	10	4.40	——
1	10	6.50	2.18	10	5.50	1.10
2	10	7.60	1.10	10	6.20	0.70
3	10	9.50	1.90	10	6.80	0.60
4	10	11.06	1.56	10	7.80	1.00
5	10	12.30	1.24	10	8.60	0.80
6	10	13.10	0.80	10	9.30	0.70
7	10	14.00	0.90	10	9.60	0.30
8	10	14.85	0.85	10	9.95	0.35
9	10	15.60	0.75	10	10.30	0.35
10	10	16.30	0.70	10	10.50	0.20
11	10	16.90	0.60	10	10.70	0.20
12	10	17.50	0.60	10	10.95	0.25
13	10	18.10	0.60	10	11.20	0.25
14	10	18.65	0.55	10	11.40	0.20
15	10	19.30	0.65	10	11.50	0.10
16	10	19.60	0.30	10	11.70	0.20
17	10	20.20	0.60	10	11.80	0.10
18	10	20.70	0.50	10	11.90	0.10
19	10	21.20	0.50	10	11.90	0.00
20	10	21.50	0.30	10	11.90	0.00
Average weekly growth	—	——	0.85	—	——	0.37

[a] Lots 1 and 2 were reared in the laboratory and given the same conditions, except that lot 1 was provided with *Ceratophyllum demersum.* Begun August 8, 1929; concluded December 26, 1929.

TABLE 3[a]

Average weekly growth of Vivipara angularis

NUMBER OF WEEKS	LOT 3			LOT 4		
	Number of snails measured	Average size	Average growth	Number of snails measured	Average size	Average growth
		mm.	*mm.*		*mm.*	*mm.*
Newly born	10	4.52	——	10	4.37	——
1	10	6.36	1.84	10	6.05	1.68
2	10	6.96	0.60	10	7.45	1.40
3	10	8.56	1.60	10	9.02	1.57
4	10	10.14	1.58	10	9.75	0.73
5	10	11.24	1.10	10	10.40	0.55
6	10	12.13	0.89	10	11.00	0.60
7	10	12.99	0.86	10	11.62	0.62
8	10	13.44	0.45	10	12.00	0.38
9	10	14.24	0.80	10	12.72	0.72
10	10	15.34	1.10	10	13.10	0.38
11	10	16.25	0.91	10	13.62	0.52
12	10	16.77	0.52	10	13.95	0.33
13	10	17.27	0.50	10	14.36	0.41
14	10	17.55	0.28	10	14.80	0.44
15	10	18.15	0.60	10	16.06	0.26
16	10	18.80	0.65	10	15.34	0.28
17	10	19.47	0.67	10	15.54	0.20
18	10	19.86	0.39	10	15.99	0.35
19	10	20.26	0.40	10	16.24	0.25
20	10	20.57	0.31	10	16.44	0.20
Average weekly growth	—	——	0.80	—	——	0.60

[a] Lot 3 was provided with twigs covered with algae, decaying organic matter in the mud, and water hyacinths, *Eichornia crassipes* Solms. Lot 4 was given only camote leaves as food. Begun August 8, 1929; concluded December 26, 1929.

TABLE 4[a]

Average weekly growth of Vivipara angularis reared under field conditions

NUMBER OF WEEKS	LOT 5			LOT 6			
	Number of snails measured	Average size	Average growth	Number of snails measured	Average size	Average growth	Average growth from lots 5 and 6
		mm.	*mm.*		*mm.*	*mm.*	*mm.*
Newly born	10	4.46	——	10	4.24	——	——
1	10	7.06	2.60	10	7.04	2.80	2.70
2	10	10.60	3.54	10	9.96	2.92	3.23
3	10	12.48	1.88	10	12.59	2.63	2.25
4	10	13.86	1.38	10	14.82	2.23	1.80
5	10	15.07	1.21	10	16.30	1.48	1.34
6	10	16.30	1.23	10	17.10	0.80	1.01
7	10	17.30	1.00	10	17.70	0.60	0.80
8	10	18.46	1.16	10	18.72	1.02	1.09
9	10	19.53	1.07	10	19.93	1.21	1.14
10	10	21.20	1.67	10	20.90	0.97	1.32
11	10	22.09	0.89	10	22.20	1.30	1.09
12	10	22.86	0.77	10	23.00	0.80	1.78
13	10	23.58	0.72	10	23.68	0.68	0.70
14	10	24.27	0.69	10	24.38	0.70	0.69
15	10	24.90	0.63	10	25.04	0.66	0.64
Average weekly growth	—	——	1.36	—	——	1.38	1.37

[a] Begun September 10, 1929; concluded December 24, 1929.

TABLE 5

Average size of Vivipara angularis at sexual maturity

DATE	NUMBER OF SNAILS EXAMINED	MATURE SIZE			
		Minimum		Maximum	
		Length	Diameter	Length	Diameter
1929		*mm.*	*mm.*	*mm.*	*mm.*
18–VI	100	18.9	15.9	24.5	18.6
25–VI	100	18.7	15.2	24.2	18.5
9–VII	100	18.6	15.4	24.5	18.7
23–VII	100	19.5	16.2	22.7	17.2
6–VIII	100	19.7	16.2	24.2	18.5
20–VIII	100	20.7	16.7	22.5	17.0
3–IX	100	19.3	16.1	22.8	17.3
17–IX	100	18.9	15.0	24.8	18.7
1–X	100	19.3	14.3	25.5	19.6
15–X	100	18.8	15.9	23.6	18.3
29–X	100	19.4	14.5	24.1	18.6
12–XI	100	19.2	16.0	23.5	18.3
26–XI	100	19.0	14.6	25.1	18.5
10–XII	100	18.8	15.2	23.8	18.4
24–XII	100	18.5	15.6	24.2	18.2
1930					
7–I	100	18.1	14.6	23.0	16.7
21–I	100	18.9	14.6	23.6	18.0
Average	—	19.09	15.41	23.90	18.18

NOTE: THE OCCURRENCE OF PYTHIUM ROOT-ROT DISEASE OF MAIZE AND SUGAR CANE IN THE PHILIPPINE ISLANDS[1]

In October, 1929 young corn plants as well as those approaching maturity were found dying prematurely because of root rot in the corn culture of the Department of Agronomy in this College. The whole root system was water-soaked with the root-tips seriously rotten and flaccid. Microscopic examinations of diseased tissues showed invariably the presence of an abundance of non-septate fungous threads and globular bodies. Isolations of a pure culture of this fungus, a *Pythium* were made by planting on steamed corn meal medium bits of diseased roots bearing incipient infections. The disease was reproduced by inoculation with the pure culture of the fungus on corn seedlings grown in sterilized soil in pots.

Sugar cane root-rot disease also caused by a *Pythium* was noted in 1926, in the sugar cane culture at this College. Numerous cases were again observed in March and in July, 1930 in the sugar cane experimental plots of the Philippine Sugar Association at Canlubang, Laguna.

Diseased canes were pale yellow, poor and of stunted growth. In affected plants the majority of the rootlets were rotten. Microscopic examinations of roots with young lesions showed that a *Pythium* causes the disease. Isolations of the *Pythium* in pure culture were made. The disease was reproduced by inoculation of single-node cuttings of the susceptible variety, Luzon White.

More detailed studies of the two diseases are being carried out under the direction of Prof. F. L. Stevens, Baker Memorial Professor in Plant Pathology, College of Agriculture, U. P.

E. F. ROLDAN,
Of the Department of Plant Pathology.

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[1] Experiment Station contribution No. 676. Received for publication August 14, 1930.

EXCHANGE NOTES

The progress of the Western civilization is marked by the improvement of the plough. The prehistoric plough was the crooked stick drawn by man. It was merely a scratching tool. Every man was his own draught animal. Somehow the farmer and his family could manage to eke out their existence with this crude method of tillage. In India too we find reference to this kind of tool in the hands of Balaram, the brother of Sri Krishna who is considered to be the father of Indian agriculture. Balaram used to carry a plough as his emblem and was also called by the name of Hala-dhara or the carrier of a plough.

In ancient Egypt a form of hoe made from a crooked stick used to serve the purpose of a plough.

The Roman plough which Virgil describes used to be made of two pieces of wood meeting at an acute angle and plated with iron.

In the middle ages no improvement of the plough was noticed. The Dutch were the first people to greatly modify the Roman plough. They first conceived the fundamental ideas of the modern plough. They made their plough with a curved mouldboard, a beam and two handles. In England in the beginning of the eighteenth century the Dutch plough served as a model. . . .

In America after the Revolutionary War the English plough was gradually replaced by ploughs made in the United States. Among those who gave first thought to the improvement of the plough, the names of Thomas Jefferson, Daniel Webster, Charles Newbold and Jethro Wood are prominent. . . .

The modern steel walking plough owes its present shape to the great American manufacturers in general and to John Deere and William Parlin in particular.

The Indian plough is a wedge-shaped toothed implement provided with one handle, a long wooden beam and a long iron pointed share all attached to its wooden body. It stirs the soil all right but inverts it very little. It closely resembles a medieval plough. It takes much time and labour to prepare a seedbed with this plough. . . .

—*The Allahabad Farmer*, (India).

Singapore was the port of shipment of canned pineapples to Europe; consequently the produce was known as the "Singapore" canned pineapple. Of recent years, however, owing to the growth of the trade, the absence of suitable and sufficient areas on the Island, and to the development of rubber cultivation on the virgin soils of Johore, the production of pineapples has become a more distinctive feature of Johore agriculture than that of Singapore, until at the present time there are more pineapple canning factories in Johore than in Singapore. Further, a factory was also opened in the State of Selangor. While practically all shipments were effected through Singapore, it was no longer correct to presume that the goods were the product of Singapore, so that the term "Malayan Pineapples" has gradually found favour as being a more accurate description. . . .

The future of the industry is of some concern to British Malaya. The exports have grown enormously, and the market is extending. On the other hand, it must be realized that practically the whole area under the crop is interplanted with rubber, which will entirely replace the pineapples in the course of about six years. The area under the crop in Malaya is between 40,000-50,000 acres, of which probably less than 5,000 acres is of pineapples treated as the main crop. It follows, therefore, that the maintenance of the canning industry depends upon new areas being opened up and planted with pineapples to replace the old areas as they drop out.

—*The Malayan Agricultural Journal.*

As soon as a coffee field shows signs of age and decay a new one should be set out. With pruning, mulching, manuring and technical treating, the trees will continue to bear a few years more—at least until the young field has got into its stride.

—*The Journal of the Jamaica Agricultural Society.*

The lettuce output for the season (1930) in Imperial Valley will probably exceed 15,000 carloads. . . .

—*California Cultivator.*

The successful growing of crops chiefly depends upon the selection of seeds for sowing. Good and healthy seeds produce strong and vigorous plants. By using very old and unselected seeds one has to sow more seeds than is actually necessary to secure even germination. Not only is this a waste but money has to be paid for dead seeds for it is well known that dead seeds will never germinate. It is therefore very important to select seeds before harvest of crops and preserve them very carefully for sowing purposes.

—*Mysore Agricultural Calendar 1930* (India).

Illinois, the greatest soybean producing state in the Union, will entertain the members of the American Soybean Association in their 11th annual meeting, September 10--12, at the University of Illinois, Urbana.

—*The Prairie Farmer.*

COLLEGE AND ALUMNI NOTES

Doctor Stevens, Baker Memorial Professor of Plant Pathology (1930-1931) gave the second of a series of semi-popular lectures in the evening of August 6. The subject was "Effect of Ultra Violet Irradiation of Fungi". Doctor Stevens gave an interesting account of how his interest in the subject was aroused and of his first attempts with irradiation of fungi with ultra-violet rays some three years ago. Some of his results he said showed that ultra violet rays in small dosages stimulated certain strains of the apple bitter-rot fungus, *Glomerella cingulata* (Stonem.) S. and V. S., which did not ordinarily produce the sexual stage, to produce perithecia abundantly in artificial culture. Some of his strains were not stimulated to perithecial production even when irradiated with ultra-violet rays. Still others produced the conidial stage more abundantly when irradiated than when they were not. The lecture was illustrated with lantern slides.

* * *

Dr. C. E. Pemberton entomologist with the Hawaiin Sugar Planters' Association was a Campus visitor recently. As Doctor Pemberton spent part of 1925-1926 on the Campus in research work for the Association, he was a most welcome visitor. He was en route to the Federated Malay States to study sugar cane pests.

In 1928 Doctor Pemberton was the entomologist in the expedition to New Guinea which used a seaplane in exploring this region for new species of sugar cane. After the expedition closed its work he stayed on for some months in Port Moresby carrying on research.

* * *

On July 10 the new Department of Soils was established by the Board of Regents, thus giving an added impetus to the work along this line in the College of Agriculture. During the past seven years this work has been carried on under the Department of Agronomy.

The soils staff, until October 1929, consisted of one Professor of Soil Technology, one graduate student assistant, and various student assistants and student laborers. Since that time the staff has been greatly strengthened. Professor Inocencio Elayda was deputed to assist in the soils work as the Extension Division had been abolished. His wide experience in Philippine agriculture, his extensive travels, and class room skill have proved of very great value in handling the large classes in the required soils courses. On August 1, 1930, Dr. Dionisio I. Aquino resumed active duty with the Soils Department. In 1926 he was granted leave to go to Ames, Iowa, where he undertook graduate studies in soils. In 1927 he received the degree of Master of Science in soil fertility; and in June, 1930, he was awarded the degree of Doctor of Philosophy in soil microbiology. In his first year he was granted a research fellowship from the Iowa Agricultural College; in his second year he was honored by a teaching fellowship from the same College, and in his third year he was a Special Fellow (half allowance only) from the University of the Philippines; and during the last year he was entirely on his own.

The creation of the Soils Department recognises the increasing importance of this subject as a separate one, and synchronizes with the awakening interest in this field in the entire Oriental Tropics. For the most part soil surveys in the Philippines have been carried on by private agencies and the surveys of their localities were made of their localities and for their special use. Dr. Robert L. Pendleton, head of the newly formed department, was asked by these agencies to make the surveys. Several summers and leave periods were spent in this manner. In a number of cases thesis students were given an opportunity to gain field experience. As a result of these surveys much material, for the most part yet unpublished, has been made available for class instruction, and a large collection of soil samples has facilitated the soils work of the students in the College. Soil surveys were made of various districts of Occidental Negros, Panay, Mindoro, and Central, and Northern Luzon. There has been issued the lithographed soil survey map of the Silay-Saravia Area, Occidental Negros, and there is now in press another soil map in colors of the La Carlota Area, also of Occidental Negros. This work has greatly extended our systematic knowledge of the soils of the Philippines, although it is as yet a mere scratching of the surface.

Other countries of the Oriental Tropics are also taking added interest in soils. China has started a soil survey; in this work this country recently asked the University of the Philippines for the assistance of Doctor Pendleton. The Secretary of the Academy of Sciences of Moscow, U. S. S. R. made a request for Doctor Pendleton as the representative of the Philippines to the Second International Congress of Soil Science that is meeting in the U. S. S. R, this summer. Although the University was unable to grant either of these requests, they indicate overseas recognition of the work being done in the College and by members of the Faculty of the College. As a further recognition, the College is represented by Doctor Pendleton, who was appointed last year a member of the sub-commission which is to compile the soil map of all Asia. This is a part of the task of compiling the world soil map, which is one of the main lines of activity of the Fifth Commission or section of the International Society of Soil Science.

THE PHILIPPINE AGRICULTURIST acknowledges the receipt of three valuable bulletins from the College of Agriculture located at Moca, Santo Domingo Republic.

One bulletin of 190 pages of printed matter, and 59 full page plates is a *General Report on the Cacao Industry of Santo Domingo* by R. Ciferri, Director of the National Agricultural Station and the College of Agriculture at Moca.

The first six chapters give a brief survey of the cacao industry the world over and of the industry in Santo Domingo in particular, statistical data on cacao production in Santo Domingo and its economic importance; a study of climatic factors; geographical distribution of same; and of the different varieties and species of cacao plants.

Chapters VII to XII are devoted to analvtical data on cacao; the technique of planting, growing, and harvesting; the study of meteorological factors and their influence upon the different stages of growth and development. There is also discussion of parasitic and non-parasitic diseases; their effect upon the industry; and how to combat them.

One of the smaller bulletins, *In Search of Monte Tina* by Dr. Erik L. Ekman gives an account of a trip to Monte Tina with the object of making a study of the flora and the physiography of the region.

The other bulletin also by Doctor Ekman is a report of *A Botanical Trip to the Northwest of the Dominican* Republic. On this trip Doctor Ekman, a botanist, was accompanied by J. Bond, an ornithologist. They made a joint study of the flora and fauna of that region, particularly of Monte Cristi.

An announcement in Science, May 30, 1930 of a meeting of the Australasian Association for the Advancement of Science held in Brisbane gave Dr. D. A. Herbert of the University in Brisbane as local honorary secretary. It will be remembered that Doctor Herbert was head of Department of Plant Physiology in this College from 1922-1924.

The Los Baños Biological Club met July 24, 1930, at 7:30 p. m., in the Lecture Hall of the Department Of Agricultural Chemistry of the College of Agriculture.

The following papers were read and discussed:

1. A fungus disease of coconut leaf miner (*Promecotheca cumingii* Baly) by Mr. M. S. Celino.
2. Observations on the activities of fowls in the laying house. (Read by Doctor Fronda), by Dr. F. M. Fronda and Mr. P. S. Paje.

The College of Agriculture now offers a revised course in Agricultural Education leading to a certificate. Under favorable conditions students may now complete the work required for both the degree of Bachelor of Science in Agriculture and Certificate in Agricultural Education within four years. No student will be granted the certificate unless he is a holder of the B. S. A. degree or the B. S. A. degree is to be conferred concurrently.

The following requirements must be met for the Certificate in Agricultural Education:

a. Students must be majoring, or have majored, in Agronomy (Farm Crops or Horticulture), Animal Husbandry or Agricultural Engineering.

b. The course requires the completion of 26 units in Agricultural Education. Considerable variation is permitted in the schedules for the certificate because of the requirements in the B.S.A. course and differences in subject requirements due to the candidates' previous teaching experience. A student who has completed the B.S.A. course before admission to the certificate course usually requires one year to complete the entire certificate course.

c. The following courses are required: Agricultural Education 1, 2, 3, 4, 101, 102, 199. The rest of the 26 units to be prescribed by the Head of the Department of Agricultural Education.

d. Students who are candidates for the certificate must file a written application at the beginning of their Junior year—or when they take up work in the Department of Agricultural Education. Admittance to candidacy will be decided by a committee composed of the heads of the departments of Agricultural Education, Agronomy, Animal Husbandry, English and Agricultural Engineering; this committee will render decision before the beginning of the next school year. The action of the committee shall be based upon the applicant's previous scholastic records and his apparent fitness for teaching.

COURSES

For undergraduates

Agricultural Education 1 (Old No. 10); Special Problems in Teaching Agriculture—Three recitations weekly, credit 3 units. Required.

Agricultural Education 2 (Old No. 11); Agricultural School Administration—Three recitations weekly, credit 3 units. Required.

Agricultural Education 3 (Old No. 2); Fundamentals in Psychology—Three recitations weekly, credit 3 units. Required.

Agricultural Education 4 (Old No. 6); Educational and Rural Sociology—Three recitations weekly, credit 3 units. Required.

Agricultural Education 10; Advanced Psychology—Three lectures weekly, credit 3 units. Elective.

Agricultural Education 11; Introduction to the History of Vocational Education—Two lectures weekly, credit 2 units. Elective.

For undergraduates and graduates

Agricultural Education 101; Special Methods in Agricultural Education—Three lectures weekly, credit 3 units. Required.

Agricultural Education 102 (Old No. 115); Observation and Supervised Teaching—By arrangement, credit 1 to 10 units. Required.

Agricultural Education 199; Seminar in Agricultural Education—One meeting a week throughout the year, credit 2 units. Required.

English 4; Letter and Report Writing—Offered by English Department and accepted as elective credit for certificate. Five recitations weekly, credit 5 units.

Recent appointments in the Department of Agricultural Chemistry are:

Julian Banzon, B. S. in Chemistry, U. P., 1930, as assistant.
Olimpio Garcia, B. S. in Chemistry, U. P., 1930, as assistant.
Ricardo T. Marfori, B. Agr. (*cum laude*) U. P., 1930, as assistant.
Delfin Suerte, B. S. S. T., U. P., 1928, as assistant in Sugar Technology

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The Mimics elected the following officers for 1930-1931—

President—Francisco Franada.
Vice-President—Honorio Ylizarde.
Secretary—Pedro Lorenzo.
Treasurer—Miguel de Guzman.
Stage Manager—Domingo Regner.
Business Manager—José Quintos.
Advertizing Manager—Lino Salazar.
Property Custodian—Ruperto Ami.

The following plays are under rehearsal—

The Trysting Place, by Booth Turkington.
The Husband of Mrs. Cruz, by Vidal Tan.
Love's Revenge by Tom Inglis Moore.

AN INTERNATIONAL PEACE GARDEN

The National Association of Gardeners in the United States are advocating the creation of an International Peace Garden somewhere on the boundary line between Canada and the United States. The proposition is sponsored by a committee of distinguished citizens of the United States and Canada. On April 20, 1930, Hon. Martin L. Davey, President of the Davey Tree Expert Company of Kent, Ohio, and former Congressman, delivered a speech on this proposition through a radio station in New York City and a network of twenty other stations.

There is a grandeur in the concept of this International Peace Garden, an appeal that warrants reprinting in this journal extracts from Mr. Davey's address.

> The idea of the International Peace Garden was conceived in the noble spirit of Henry J. Moore, Lecturing Horticulturist for the Province of Ontario. It was proposed at the annual convention of the National Association of Gardeners in the City of Toronto last August, and was received with moving enthusiasm and with the fervor of a great crusade. Without a dissenting voice and in the spirit of earnest purpose, it was decided to accept the heavy responsibility of sponsoring this monumental project.
>
> For more than a hundred years, peace has reigned inviolate between the peoples of Canada and the United States. No finer example of neighborliness or enduring friendship could be found in the world than that which exists between these two adjoining countries of the North American Continent.
>
> How appropriate it is, then, that an International Peace Garden should be created on the imaginary boundary, half on one side and half on the other. It is proposed that this Garden shall be a thousand or more acres in area, and that it be located some place on the line where it will be accessible to the greatest number of people.
>
> In it will be planted all the varieties of trees, and flowers, and shrubs that can be grown in this latitude—beautiful living things that will speak more eloquently of the fact of peace and the will to peace than any towering monument built of cold and inanimate stone. Many of these growing things will be contributed out of the abundance on the private places in both countries, but the work of creating it will require a considerable investment. Then there will follow, in a natural course, the problem of raising a sufficient endowment to maintain it into the long distant future. . . . .
>
> It seems to me that no more useful thing could be done than to enlist the school children in this spiritual and intellectual stimulation. To think peace is to live peace. To think it actively and consciously is to build up in the on-coming generation the spirit and the will to peace. If we receive nothing more than the development of this fine philosophy of neighborly living, we will have been compensated a thousand times for all the effort and all the cost. . . . .

THE PHILIPPINE AGRICULTURIST, VOL. XIX, NO. 6, NOVEMBER, 1930.

Man could build countless monuments of steel and marble, and place them at frequent intervals along the extensive boundary line, but each one would be cold and forbidding, and could not kindle the fires of enthusiasm in a single human breast, nor inspire one mortal being to loftier sentiment.

There is something about this idea of an International Garden, with living trees and flowers and shrubs, that stirs the imagination. It seems to be so fitting for this purpose. It is such an appropriate manifestation of human ideals. It is so expressive of the finer qualities of human nature. It is at once satisfying and uplifting.

Year after year innumerable people will travel to see it and will think the thoughts of peace. They will be moved to a keener realization of the fortunate circumstances under which we are permitted to live as friends and mutual well-wishers. They will carry back home with them a new sense of their own responsibilities as neighbors. . . . .

How appropriate it is, in this significant period when sincere efforts are being made by the leaders of the great nations of the world to arrive at mutual understanding and to provide a more permanent basis for world peace, that this International Garden should be projected! What a happy thought it is that inanimate steel and marble should be eliminated from its being, and that no cannon or other sign of strife should have any place in its creation or existence! It is to be just an immense garden of growing things, where beauty reigns and where friendship is the theme. It seems to me that in such a place, where the nobility of two great peoples is merged in a common undertaking, that the foliage ought to be more luxuriant and have greater luster, and that the colors in the flowers should be richer and more glorious. The birds should sing more merrily, and the sun shine more brightly. Even after the storm clouds have passed away, the colors of the rainbow should be more brilliant and should cast their radiance far beyond their usual limitations.

Canada and the United States have offered to the world an example that is worthy of admiration and emulation. We have lived as neighbors without the necessity of armed strife for more than a century. There lies between us an imaginary dividing line of some three thousand miles in length. Not a fort or a battleship has been found necessary along that far-flung border. Not a soldier needs to be stationed there. We have business and social and political intercourse without the remotest necessity of military maneuvers. We understand each other. Each people forges ahead to its own logical destiny in its own way, and each respects the rights of the other. . . . .

All the eloquence of Demosthenes, all the logic of Cicero, and all the mastery of Shakespeare cannot compare with the powerful appeal of the International Peace Garden to the hearts and minds of those who live upon this continent, and those from other lands who come to see, with minds that understand and hearts that comprehend. The language of trees and flowers and shrubs, though mute and inaudible, will be more eloquent and more convincing than the language of statesmen, philosophers, and poets. This International Peace Garden will proclaim the lofty spirit of two great countries. Yes, it will be a glorious and beautiful picture of the soul of the people.

Out of each 1,000,000 without schooling, only 6 attain distinction.

Out of each 1,000,000 with elementary schooling, 24 attain distinction.

Out of each 1,000,000 with high-school education, 622 attain distinction.

Out of each 1,000,000 with college education, 5768 attain distinction.

So it seems that for all their faults, and their faults are many, the schools are a good investment.—*President Frank, University of Wisconsin, in the Journal of Education.* Reprinted in *What The Colleges Are Doing.*

FACTORS IN THE COST OF EGG PRODUCTION[1]

F. M. FRONDA AND PEDRO S. PAJE[2]
Of the Department of Animal Husbandry

WITH FOUR CHARTS

Of the various phases of poultry raising, whether carried on as a side line of general farming or as a commercial enterprise, the production of eggs is the most interesting. The eggs are also one of the most important market products of poultry. Some of the most common questions asked by people interested in poultry production are the following: Does it pay to raise chickens for the production of market eggs? How much feed is necessary to produce a dozen eggs? What expenses other than feed enter into the cost of producing eggs? To be able to answer questions of this tenor led to the carrying on of the studies the results of which are reported in this paper.

It is true that in other countries numerous reports along this line have been published. But as conditions in the Philippines vary considerably from those in the countries where those observations were made, the data reported are of very little value, if any at all, to poultry raisers in this country. The absence of figures obtained under local conditions make this study very timely, and the data here reported should be of value in guiding Philippine poultry raisers in making their enterprise both pleasurable and profitable.

This study was conducted in the College of Agriculture, Los Baños. It covered a period of exactly one year, from September 1, 1928, to August 31, 1929.

METHODS

Three flocks, containing fifty Cantonese layers each, were used in this study. In one of these flocks were pullets only, in another yearlings, and in the third only hens.[3] The idea in thus grouping the birds was to determine at which age chickens produce most profitably. It may be mentioned here that the birds that composed each of the groups were picked at random from the main Cantonese flock of the College.

No special effort was made in the feeding and care of the birds. The feed given them, although it varied slightly in amounts in the different flocks, depending upon the needs of the birds, was the same as that given to the main flock. The grain feed consisted of equal parts by weight of corn and palay, and the mash was composed of four parts of rice bran, three of copra meal, two of corn meal, and one of ground dried shrimps. There were a few instances when this mixture was varied slightly, but whenever changes were made, these were similar in all the three lots. The grain was hand-fed morning and afternoon and the mash mixture was fed in dry mash feeding troughs which were kept open at all times. Efforts, however, were made to feed one part of the grain to one of the mash mixture. Using the prices of the different ingredients of this ration that prevailed during the year this study was being conducted, 1928-1929, this ration cost approximately ₱0.09 a kilogram.

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[1] Experiment Station contribution No. 678. Received for publication September 1, 1930.

[2] Mr. Paje resigned from the position as graduate assistant in Animal Husbandry, July 1, 1930.

[3] Pullets, as used in this study, are birds that are in their first laying year; yearlings are those that are in their second laying year; and hens are those that are in their third laying year.

The birds were trapnested throughout the year. In recording the eggs, care was exercised to determine the grade of the eggs that were laid. Two classes were recognized; those eggs that weighed less than 42.5 grams were recorded as "pullet" eggs, and those that weighed 42.5 grams each or over were recorded as "standard" eggs. This classification will be of significance in determining the values of the eggs laid by the different groups, as the pullet eggs were sold at ₱0.04 each, whereas the standard eggs were marketed at ₱0.05 each.

CAPITAL CHARGES

In the determination of the net cost of production, the amount of ₱170.04 was subtracted from the gross receipts of each lot studied, calculated on the basis of 100 birds. The gross receipts had to be computed on the basis of 100 birds for the reason that charges on the fixed capital, such as building and appliances, fences, depreciation, repairs and use of the land, were made on the basis of the entire plant which had a carrying capacity of double the number of birds used in this study. For this reason, the interest on the capital stock, and the insurance were charged on the basis of 100 birds also. The amount of ₱170.04 represents all charges on the capital invested, and is distributed as follows:

Interest on capital stock. The local selling price of the birds used in this study was ₱3.00 each. Since there were 50 birds in each pen, and the rate of 6 per cent per annum was charged, the interest on capital stock chargeable against each pen was ₱9.00. For the purposes of computation the capital charge on 100 birds would be ₱18.00 each pen.

Labor. One man earning ₱1.50 a day was regularly employed in the care and feeding of all the flocks of the College. On this basis, it was estimated that the cost of labor utilized in the care of each of the three pens used in this study computed for 100 birds was ₱79.80. This labor was used in the care and feeding of the birds, cleaning of the pens and yards, and for the various minor chores of the daily routine of management.

Use of building and fences. The chickens used in this study were penned in a 300-hen laying house, which, together with the fences and appliances, was valued at ₱1,455.00. Placing the rate of interest at 6 per cent per annum, the charge against the flocks for the use of the building and fences therefore amounted to ₱87.30, or ₱29.10 each pen.

Use of land. Three yards with a total area of 1,224 square meters were used. At ₱500.00 a hectare, with interest at 6 per cent, the charge for the use of land was placed at ₱1.22 each pen.

Depreciation. The building and fences were estimated to last for 30 years; the depreciation, therefore, at 3.3 per cent amount to ₱48.02 a year or ₱16.01 each pen used.

Insurance. The rate of insurance used for animals was 5 per cent and for building, 0.25 per cent. As already stated the birds were valued at ₱3.00 each, the local selling price. At 5 per cent per annum, the animal insurance for each pen of 50 layers amounted to ₱7.50. Doubled, it would be ₱15.00. Adding this amount to the insurance on building and fence at the rate of 0.25 per cent, the total insurance chargeable against each pen would be ₱16.21.

Repairs. For repairs of the building and fences, the rate of 2 per cent was used. The amount chargeable against each pen therefore was ₱9.70.

RESULTS AND DISCUSSION

Weight. Table 1 gives the number and average weights of the birds at the beginning and at the close of the study. From this table it may be seen that there was a slight difference in the size of the birds in lot 2, yearlings, and lot 3, hens. The smallest birds, as was expected for the reason that they were young and still growing, were found in lot 1, pullets. By comparing the average weights of the birds at the beginning of the experiment with those at the close, it may be seen that the birds in all the three lots gained in weight. There was practically no difference in the amount of gains made by the pullets and yearlings; but the hens tended to become fatter towards the close. The pullets (lot 1) when placed in the laying house at the beginning of the study were just starting to lay and had not reached their maximum size, hence, at the close of the experiment, they did not seem fat, whereas, the birds in both lots 2 and 3 were rather fat. The increase in weight of the pullets was apparently due principally to increased body tissues, such as bones and muscles. The added weights in case of the yearlings and hens were, to a great extent, due to deposits of fat, most of the birds having rather thick deposits of fat in the abdomen, as determined when these were handled at end of the study.

It is of interest to note in this connection that the percentage of mortality during the year in the three lots varied from only 6.0 to 12.0. While there may be a slight significance in the mortality figures as given in table 1, they are all within the normal range of mortality, which among layers, is generally considered to be 12 per cent a year. With good feeding and a reasonable amount of attention to sanitation and general cleanliness of the premises, there is no reason why mortality in a laying pen should go beyond this normal range. The figures obtained in this study, however, indicated that a higher percentage of mortality may be expected with the older hens than with the younger.

Egg production. The percentage of monthly egg production of the different flocks studied are given in table 2 and graphically represented in chart 1. Percentage of egg production was determined by dividing the actual number of eggs laid by the total number of possible eggs and multiplying the quotient by 100. In the construction of this table, the total number of eggs, irrespective of the size of the individual eggs produced, was used.

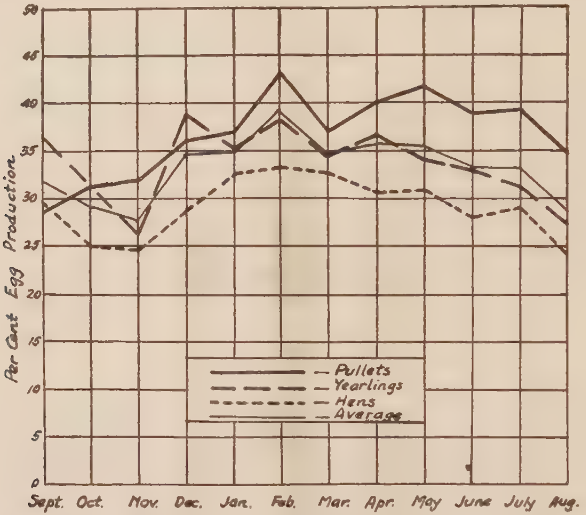

Chart 1.—The monthly egg production of the different lots, expressed in percentage of the entire flock.

By reference to this table, as well as to chart 1, it can be seen that the trend of egg production in all the three lots was fairly uniform. Except in a few instances in the early part of the experiment, the pullets laid the largest number of eggs, the average monthly production being 36.7 per cent. The yearlings, with an average of 33.6 per cent, followed next, and the hens with an average of only 29.0 per cent were the lowest producers. The drop of egg production of the yearlings and the hens from September to November was expected, as, during this period, these birds were completing their molting. The pullets at the beginning of the experiment were just coming into production and were producing about 30 per cent. This curve of egg production gradually increased and from the month of January to the close of the study the pullets were laying more eggs than either the yearlings or the hens.

These results are similar to those observed in other countries, which may be briefly stated as follows: The second year's production, the yearling year, shows a decrease as compared with the first year (Atwood, 1928). Hens produce less than the yearlings, and much less than the pullets. Bell, Alder, and Egbert (1916) observed that among White Leghorns, the average egg production during the first laying year was 130, 120 during the second, and, during the third, it was 111 eggs each. In the present study, the pullets, lot 1, averaged 133.7 eggs each during the year, the yearlings 119.2 eggs each, but the hens averaged only 105.2 eggs each. These figures are graphically represented in chart 2.

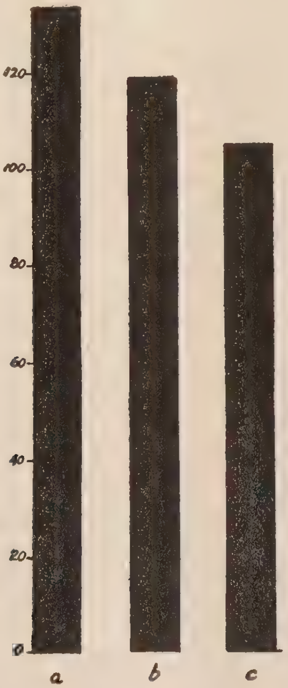

Chart 2.—The average annual egg production of the different groups of birds studied: (*a*) pullets, (*b*) yearlings, (*c*) hens.

Value of eggs produced. Table 3 gives the actual number of eggs produced monthly by the different flocks. These eggs were classified into two grades, pullet and standard eggs. Of the total of 6380 eggs produced by the pullet pen, 3,335 or 52.3 per cent were standard eggs and 3,045 or 47.7 per cent were pullet eggs. These were valued at ₱288.55. The yearlings produced 4,135 or 72.9 per cent standard eggs and only 1,539 or 27.1 per cent pullets; the total was valued at ₱268.31. Of the total of 5,048 eggs produced by the hens, 2,704 eggs or 53.6 per cent were standards, and 2,344 or 46.4 per cent were pullets. The total value of these eggs was ₱228.96. Calculated on the individual bird basis, the average value of the eggs produced by each pullet was ₱6.05, by each yearling, ₱5.64, and by each hen only ₱4.79. The relative distribution of standard and pullet eggs produced in these three groups of chickens seem to agree with the results of eight separate tests of Single Comb White Leghorn hens and pullets made by Stewart and Atwood (1909) in which they concluded among other things that the eggs from pullets were smaller than those from the older birds.

Amount of feed consumed. No restriction was made on the amount of feed consumed by the birds. Efforts, however, were exerted so as to enable the birds to consume approximately the same amount of grain and mash so that errors that may be due to difference in the composition of feeds eaten by the birds in the different lots might be reduced to a minimum.

Tables 4, 5, and 6 give the amount and cost of feeds consumed by the three pens used in this study. By reference to these tables, it may be seen that, in general, the total amount of feeds eaten by the different groups of layers did not vary materially, as there was no significant difference in the total feed consumption of the different pens. In all pens, the grain consumption was slightly higher than the mash. In a test carried on by Amon (1930) in which the birds were allowed to balance their own ration from feeds that were placed in separate containers, it was observed that the birds consumed more of the grain than the sum total of all the ground feeds given them. When computed on the basis of individual bird consumption, it may be seen in all the three pens that each bird consumed about 28.5 kilograms of feed.

The total cost of the feeds consumed by the pullets was ₱123.26 or ₱2.58 per bird. The yearling pen consumed ₱122.63 worth of feeds or ₱2.57 each bird. The hens consumed ₱128.12 worth of feeds or ₱2.58 each hen. Thus, irrespective of the age and size of the birds, the amount and cost of feeds consumed was approximately the same. The pullets may be smaller than either the yearlings or the hens (see table 1), but then they laid many more eggs than these. The hens' consumption did not materially differ from that of the yearlings, in spite of the fact that the yearlings laid more eggs than the hens. The slight difference in the size of the birds, and the slight difference in the number of eggs laid by them probably did not have any appreciable effect on the amount of feed consumption. However, it is a matter of general knowledge that as the birds grow older, they are not as efficient in the use of the food materials given them as they are when younger. This is especially true in case of egg production, as more of the food materials are transformed into fat than into eggs in case of older individuals.

Value of eggs over the cost of feeds. The figures given in table 7 were computed from tables 3, 4, 5, and 6. A better comparison of the different pens may be had by referring to the computed data for every 100 individuals.

As was expected, the Cantonese pullets brought in the highest returns above the cost of feeds, the yearlings ranked the next, and the hens, the least. Except during the first two months of the study when not all of the pullets were laying, the pullet pen led both the yearlings and the hens during the period of study. The returns above the cost of feeds gradually increased from the first month up to January, when the income reached a figure that was fairly well maintained up to June. Beginning this month, the returns above the cost of feeds began to decrease gradually.

The yearlings began at a high level which gradually decreased until December. The returns above the cost of feeds began to increase from January, and this figure was maintained until June when it began to decrease, reaching the minimum in August. The Cantonese hens had a similar distribution of returns over the cost of feeds. In this case, the minimum monthly return above the cost of feeds was ₱10.28; this was obtained during August. The actual returns above the cost of feeds from the Cantonese pullets was ₱165.29, from the yearlings, ₱145.61 and only ₱105.93 from the hens. Computed on the basis of 100 individuals, these would be ₱347.38 ₱305.43, and ₱221.83 for the pullets, yearlings, and hens, respectively.

Feed consumption and egg production. By reference to table 8, the amount and cost of feeds consumed to produce a dozen eggs may be seen. To obtain these figures, the actual amounts of feeds consumed, in kilograms, was divided by the actual number of eggs produced; the quotient multiplied by 12 gave the amount of feeds needed to produce a dozen eggs. The results when multiplied by the price of the feed for every kilogram gave the cost of the feeds consumed for every dozen of eggs produced.

The data show conclusively that the pullets produced the most economical eggs, the yearlings next, and the hens the most expensive. On the average, it needed only 2.60 kilograms of feed consisting of both grain and mash, costing ₱0.234, to produce one dozen eggs among the Cantonese pullets. It needed 2.84 kilograms of feed, costing ₱0.263, to produce a dozen eggs among the Cantonese yearlings, whereas 3.28 kilograms costing ₱0.295 were needed by the Cantonese hens to produce the same number of eggs.

By studying table 8, it may be seen also that the most economical eggs were produced during May among both the Cantonese pullets and yearlings, but in the case of the hens, these were produced in March. It was expected that eggs would be produced most economically in March. It was expected that eggs would be produced the most economically during the months of highest production (see table 2 and chart 1), but as may be seen also in tables 4, 5, and 6, the feed consumption during these months in all the three lots was rather heavy.

Among the pullets, the most expensive eggs were produced during the first few months after the birds were placed in the laying house. Not all of the birds at this period had completed their growth, so that the heavy consumption of feeds during these months was needed both for egg production and for growth. Both among the Cantonese yearlings and hens, the eggs produced during November and December were rather expensive also. During this period, egg production was naturally low, and the birds were probably accumulating energy preparatory for the breeding season. It would be expected that these two pens would produce expensive eggs the last month of the study as these birds were then starting to molt,and egg production was gradually decreasing. This distribution of egg production among the Cantonese fowls is absolutely normal, as shown by Fronda (1928) in his report of a five-year observation on the egg production of fowls in this College.

Profits. Table 9 gives a statement showing the summary of all expenses incurred, computed on the basis of 100 individuals. The total expenses incurred, which amounted to ₱428.16 in the pullet pen, ₱428.00 among the yearlings, and ₱427.31 among the hens, include the cost of the feeds consumed (see tables 4, 5, and 6), the cost of labor and the capital charges. The cost of feeds consumed by the different pens was practically the same. The capital charges which include the interest on the capital invested in the stock, the use of building and land, repairs, depreciation, and insurance on both the animals used and the building amounted to ₱90.24 for each pen. The cost of labor alone was ₱79.80, and this amount was charged against each of the pens.

All of these expenses were deducted from the total receipts from the sale of eggs, computed on the basis of 100 birds (see table 10). The cost of the manure was not taken into consideration, as no record was kept of this. By reference to table 10, it will be seen that the largest net return was made by the pullet pen which amounted to ₱176.77; this was closely followed by the yearling pen with ₱136.94 to its credit. The hens brought in the smallest net income, only ₱51.90 for the year.

Comparing these returns with the total amount of expenses incurred in the operation, it may be seen that the pullets earned 41.3 per cent, the yearlings, 32.0 per cent, while the hens earned only 12.1 per cent. These results show conclusively that both the pullets and the yearlings should be preferred in raising chickens for the production of market eggs, for these are much more profitable than the hens.

Factors in the cost of egg production. By reference to table 9 (see also chart 3) it may be seen that the feed constituted the bulk of all the expenses incurred in the production of eggs. This amount, as has been stated elsewhere in this paper, was practically the same in all of the pens studied. All the other expenses, which include the cost of labor and the capital charges, were the same. The average for the three pens is shown graphically in chart 3

Chart 3.—The expenses incurred in the production of eggs. (*a*) Feed—60.3%; (*b*) labor—18.6%; (*c*) use of building and fences—6.8%; (*d*) interest on capital stock—4.2%; (*e*) depreciation—3.7%; (*f*) insurance—3.8%; (*g*) repairs—2.3%; and (*h*) use of land—0.3%.

By reference to table 9 it may be observed that on the average 60.3 per cent of the total expenses of production was due to feeds. This is followed by the labor charges which amounted to 18.6 per cent. The use of building, including repairs, with the use of land, amounted to about 10 per cent of the total expenses. The other expenses are about equally divided between the interest on the capital invested in the stock, the depreciation of the building and fences, and the insurance of both the stock and the building.

From the figures given in table 9 and using the average cost of the feeds consumed to produce a dozen eggs (see table 8), the actual cost of production was computed. The results are given in table 11; by reference to this, it may be noted that with all expenses included, it actually cost 38.8 centavos to produce a dozen eggs among the Cantonese pullets; 43.6 centavos among the yearlings; and 49.0 centavos among the hens. The different items of expenses in the production of eggs are also given in table 11.

From the actual amounts of feeds needed to produce eggs during the different months of the year by the Cantonese pullets, yearlings, and hens, respectively (see also table 8) the data given in table 12 were obtained. The figures in this table, the average of which are graphically shown in chart 4, show the actual cost of producing the eggs when all the other items of expense are included. This table will serve as a guide for the producer as to the rate at which the eggs may be sold during the different months of the year in order to break even. Whatever the difference between this absolute cost of producing a dozen eggs and the current price of the eggs represents the profits earned for every dozen eggs sold.

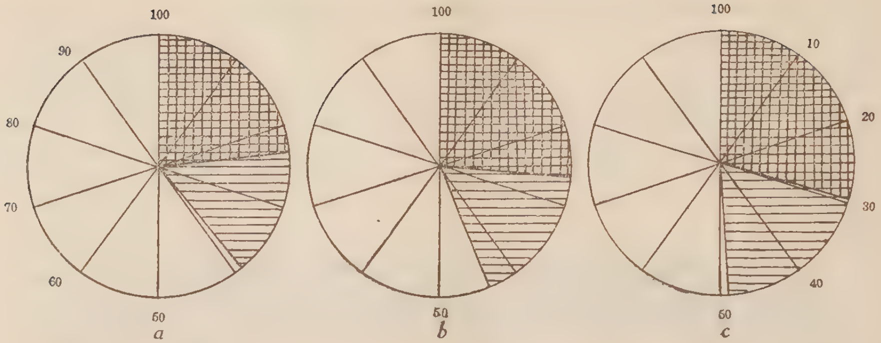

Chart 4.—The poultryman's income. The shaded portion represents the cost of producing one dozen eggs among (*a*) pullets, (*b*) yearlings and (*c*) hens. The part with cross lines represents the cost of feeds alone; and the remaining part of the shaded area, the other expenses. Any amount the poultryman receives for every dozen eggs he sells beyond the shaded portion represents his net income.

SUMMARY AND CONCLUSIONS

1. The results of studies on the cost of egg production by Cantonese pullets, yearlings, and hens are reported in this paper.

2. The pullets laid the largest number of eggs, followed by the yearlings, and the hens laid the smallest number. The total value of all the eggs produced was also largest in the pullet pen, next in the yearling pen, and the lowest in the hen pen.

3. The amount of feeds consumed by the different lots was practically the same.

4. To produce a dozen eggs, it needed only 2.60 kgm. of feeds among the pullets, 2.84 kgm. among the yearlings, and 3.28 kgm. among the hens.

5. The most economical eggs were produced by the pullets. The hens produced the most expensive eggs.

6. It was observed that the most economical eggs were produced during May by both the Cantonese pullets and yearlings, but during March by the hens.

7. It was observed that it cost an average of ₱257.78 to feed 100 Cantonese layers a year.

8. The net income derived during the year from 100 Cantonese pullets was ₱176.77; ₱136.94 from the yearlings, and only ₱51.90 from the hens.

9. Considering the total expenses incurred, the net income derived from the different pens represented 41.3 per cent for the pullets, 32.0 per cent for the yearlings, and 12.1 per cent for the hens.

10. The various charges which include the cost of labor, interest on the capital invested in the stock, the use of the building and land, de-

preciation and insurance on both the animals and the building used amounted to ₱170.04 for the year.

11. Of the amount of expenses incurred in egg production, feed alone represented 60.3 per cent, labor 18.6 per cent, and all the remainder of the total is the capital charges.

12. The results conclusively showed that pullets are the most profitable to raise, the yearlings followed as a close second, and the hens are the least profitable.

13. The results obtained also show that with the proper kind of stock and good feeding, poultry raising for the production of table eggs may be profitably carried on as a business undertaking.

14. The results further show that with good feeding and reasonable amount of attention given to proper sanitation and general cleanliness of the premises, the mortality in a laying pen need not go beyond the normal range of 12 per cent a year.

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TABLE 1

Giving the number and weights of the birds at the beginning and at the end of the study

	LOT 1 PULLETS	LOT 2 YEARLINGS	LOT 3 HENS
Number of birds at the beginning, Sept. 1, 1928	50	50	50
Average weight of the birds at the beginning	1196.5 grams	1374.0 grams	1325.4 grams
Number of birds at the close, Aug. 31, 1929	47	45	44
Average weight of the birds at the close	1373.4 grams	1532.2 grams	1540.2 grams
Number of birds that died during the year	3	5	6
Percentage of mortality during the year	6.0	10.0	12.0

TABLE 2

Percentage of monthly egg production of the different pens

MONTH	PULLETS	YEARLINGS	HENS	AVERAGE
September	28.5	36.8	29.5	31.6
October	31.3	31.3	25.0	29.2
November	32.0	26.1	24.5	27.5
December	36.2	38.6	28.6	34.5
January	37.0	35.1	32.4	34.8
February	42.9	38.4	33.2	38.2
March	37.1	34.4	32.6	34.7
April	40.1	36.5	30.6	35.7
May	41.8	34.1	30.8	35.6
June	38.7	32.9	28.0	33.2
July	39.4	31.3	29.0	33.2
August	34.8	27.4	24.0	28.7
Average	36.7	33.6	29.0	33.1

TABLE 3

Number and value of eggs produced in the different flocks[a]

MONTHS	PULLETS		YEARLINGS		HENS	
	Number	Value	Number	Value	Number	Value
		pesos		*pesos*		*pesos*
September..	427	20.42	548	27.12	442	21.08
October....	475	22.58	476	23.32	387	18.33
November..	470	21.50	386	18.60	362	16.48
December..	538	25.55	431	20.99	425	19.58
January....	544	26.37	522	25.92	474	22.38
February...	564	26.87	521	25.26	437	20.09
March.....	541	24.35	503	23.79	474	21.38
April.......	586	25.61	514	23.67	432	18.98
May.......	610	26.49	497	22.80	449	20.05
June.......	545	23.79	454	20.23	395	17.22
July.......	573	23.89	440	19.63	423	18.34
August.....	507	21.13	382	16.98	348	15.05
Total......	6380	288.55	5674	268.31	5048	228.96

[a] Standard eggs were sold at ₱0.05 and pullet eggs at ₱0.04 each.

TABLE 4

Amount and cost of feeds consumed by Cantonese pullets

MONTHS	ACTUAL AMOUNT OF FEED CONSUMED			AMOUNT AND COST OF FEED CONSUMED COMPUTED FOR EVERY 100 BIRDS	
	Mash	Grain	Total	Amount of feed	Cost
September..........	60.0	60.0	120.0	240.0	₱21.60
October [a]..........	60.0	55.2	115.2	235.1	21.16
November..........	55.6	49.3	104.9	214.1	19.27
December [a].........	64.4	70.7	135.1	281.4	25.33
January [a]..........	60.0	53.0	113.0	237.9	21.14
February..........	60.0	60.0	120.0	255.3	22.98
March............	60.0	50.0	110.0	234.0	21.06
April..............	60.0	50.0	110.0	234.0	21.06
May..............	60.0	50.0	110.0	234.0	21.06
June..............	60.0	48.0	108.0	229.8	20.68
July..............	60.0	52.5	112.5	239.4	21.55
August............	60.0	50.9	110.9	235.9	21.23
Total.............	720.0	649.6	1369.6[b]	2870.9	258.12

[a] One bird died.

[b] Total number of birds, 47.7.

TABLE 5

Amount and cost of feeds consumed by Cantonese yearlings

MONTHS	ACTUAL AMOUNT OF FEED CONSUMED			AMOUNT AND COST OF FEED CONSUMED COMPUTED FOR EVERY 100 BIRDS	
	Mash	Grain	Total	Amount of feed	Cost
September [a]	58.0	58.0	116.0	235.5	₱21.18
October	60.0	54.0	114.0	232.8	20.95
November	54.6	51.0	105.6	215.5	19.40
December	65.4	69.0	134.4	274.1	24.67
January [a]	60.0	60.0	120.0	250.0	22.50
February	60.0	52.0	112.0	233.3	21.00
March [a]	51.1	60.0	111.1	235.9	21.23
April	57.5	55.0	112.5	239.4	21.55
May	55.0	52.0	107.0	227.7	20.49
June	60.0	48.0	108.0	229.8	20.68
July [b]	60.0	49.5	109.5	241.2	21.71
August	60.0	53.2	113.2	251.1	22.60
Total	701.6	661.0	1362.6[c]	2861.1	257.96

[a] One bird died.

[b] Two birds died.

[c] Total number of birds, 47.6.

TABLE 6

Amount and cost of feeds consumed by Cantonese hens

MONTHS	ACTUAL AMOUNT OF FEED CONSUMED			AMOUNT AND COST OF FEED CONSUMED COMPUTED FOR EVERY 100 BIRDS	
	Mash	Grain	Total	Amount of feed	Cost
September	58.0	58.0	116.0	232.0	₱20.88
October	60.0	54.5	114.5	229.0	20.71
November [a]	56.4	53.5	109.9	223.4	20.11
December [a]	63.6	61.5	124.1	258.5	23.26
January [a]	60.0	60.0	120.0	252.8	22.75
February	60.0	51.0	111.0	236.1	21.25
March	51.5	60.0	111.5	237.2	21.35
April	57.5	54.5	112.0	238.3	21.45
May	60.0	52.0	112.0	238.3	21.45
June	60.0	51.0	111.0	236.1	21.25
July	60.0	51.0	111.0	236.1	21.25
August [a]	60.0	54.0	114.0	244.6	22.01
Total	707.0	661.0	1368.0[b]	2862.4	257.27

[a] One bird died.

[b] Total number of birds, 47.8.

TABLE 7

Returns over the cost of feeds, actual for each pen and as calculated for 100 birds

MONTHS	PULLETS		YEARLINGS		HENS	
	Actual	Computed for 100 birds	Actual	Computed for 100 birds	Actual	Computed for 100 birds
	pesos	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*
September.	9.62	19.24	16.68	33.83	10.64	21.28
October.	12.22	24.93	13.06	26.65	8.02	16.04
November.	12.06	24.61	9.11	18.59	6.59	13.39
December.	13.39	27.89	8.89	18.14	8.42	17.54
January.	16.20	34.11	15.12	31.50	11.58	24.38
February.	16.07	34.19	15.18	31.63	10.10	21.49
March.	14.45	30.74	13.79	29.29	11.34	24.13
April.	15.71	33.43	13.54	28.81	8.90	18.94
May.	16.59	35.30	13.17	28.02	9.97	21.21
June.	14.07	29.94	10.51	22.36	7.23	15.38
July.	13.76	29.28	9.77	21.52	8.35	17.77
August.	11.15	23.72	6.79	15.09	4.79	10.28
Total.	165.29	347.38	145.61	305.43	105.93	221.83

TABLE 8

Amount and cost of feeds consumed to produce a dozen eggs among Cantonese pullets, yearlings and hens

MONTHS	PULLETS		YEARLINGS		HENS	
	Amount	Cost	Amount	Cost	Amount	Cost
	kgm.	*centavos*	*kgm.*	*centavos*	*kgm.*	*centavos*
September.	3.37	30.3	2.54	22.8	3.14	28.3
October.	2.91	26.2	2.87	25.8	3.55	32.0
November.	2.68	24.1	3.29	29.6	3.65	32.9
December.	3.01	27.1	3.74	33.7	3.50	31.5
January.	2.50	22.5	2.76	24.8	3.04	27.4
February.	2.56	23.0	2.58	23.2	3.05	27.5
March.	2.44	22.0	2.65	23.8	2.82	25.4
April.	2.26	20.3	2.63	23.7	3.11	28.0
May.	2.16	19.5	2.58	23.2	2.99	26.9
June.	2.38	21.4	2.86	25.7	3.37	30.4
July.	2.35	21.2	2.99	26.9	3.14	28.3
August.	2.63	23.7	3.55	32.0	3.94	35.5
Average.	2.60	23.4	2.84	26.3	3.28	29.5

TABLE 9

Statement showing summary of expenses incurred in egg production computed on the basis of 100 birds

ITEMS	PULLETS		YEARLINGS		HENS	
	Amount	Per cent	Amount	Per cent	Amount	Per cent
	pesos		*pesos*		*pesos*	
Feed	258.12	60.3	257.96	60.3	257.27	60.2
Labor	79.80	18.6	79.80	18.6	79.80	18.7
Use of building and fences	29.10	6.8	29.10	6.8	29.10	6.8
Interest on capital stock	18.00	4.2	18.00	4.2	18.00	4.2
Depreciation	16.01	3.7	16.01	3.7	16.01	3.7
Insurance	16.21	3.8	16.21	3.8	16.21	3.8
Repairs	9.70	2.3	9.70	2.3	9.70	2.3
Use of land	1.22	0.3	1.22	0.3	1.22	0.3
Total	428.16	100.0	428.00	100.0	427.31	100.0

TABLF 10

Statement showing summary of transactions, computed on the basis of 100 birds

ITEMS	PULLETS	YEARLINGS	HENS	AVERAGE
Receipts from sale of eggs	₱604.93	₱564.94	₱479.21	₱549.69
Total expenses (including cost of feed and capital charges)	428.16	428.00	427.31	427.82
Net returns	₱176.77	₱136.94	₱ 51.90	₱121.87
Percentage of returns (based on total expenses incurred)	41.3	32.0	12.1	28.4

TABLE 11

Itemized cost of producing one dozen eggs

ITEMS	PULLETS	YEARLINGS	HENS
	centavos	*centavos*	*centavos*
Feeds	23.4	26.3	29.5
Labor	7.2	8.1	9.1
Use of building and fences	2.6	3.0	3.3
Interest on capital stock	1.6	1.8	2.1
Insurance	1.5	1.7	1.9
Depreciation	1.4	1.6	1.8
Repairs and use of land	1.0	1.1	1.3
Total	38.8	43.6	49.0

TABLE 12

The actual cost of producing one dozen eggs during the different months of the year

MONTHS	PULLETS	YEARLINGS	HENS
	centavos	*centavos*	*centavos*
September.....	50.2	37.8	47.0
October.......	43.4	42.8	53.2
November.....	40.0	49.1	54.7
December.....	45.0	56.9	52.3
January.......	37.3	41.2	45.5
February......	38.1	38.5	45.7
March........	36.5	39.5	42.2
April.........	33.7	39.3	46.6
May..........	32.3	38.5	44.7
June..........	35.5	42.6	50.5
July..........	35.1	44.6	47.0
August........	39.3	53.1	58.0
Average.......	38.8	43.6	49.0

SOME STUDIES ON THE BIOLOGY OF TULLA (CORBICULA MANILLENSIS PHILIPPI), A COMMON FOOD CLAM OF LAGUNA DE BAY AND ITS TRIBUTARIES[1]

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Of the Department of Entomology

WITH ONE PLATE, SEVEN CHARTS, AND TWO TEXT FIGURES

INTRODUCTION

The present report deals with the results of certain studies on the biology of *Corbicula manillensis* Philippi that were carried on with the end in view of finding a solution for some of the most pressing problems related to the conservation of this bivalve. As this clam is of great economic value to the inhabitants of the Laguna de Bay regions, the proper solution of these problems is of practical importance.

C. manillensis is the only bivalve that is gathered in quantities approaching a commercial scale in Laguna de Bay and its tributaries. It is used extensively as food for *itek* (domesticated ducks, *Anas boschas* Linn.) especially when *susong pangpang* (*Vivipara angularis* Müller) and *susong buele* (*Melania lateritia*, *M. pantherina*, *M. scabra*), their usual principal protein food is scarce.

The *tulla* is used also for food by the native inhabitants, especially by the laboring class. In some places in Laguna de Bay regions the shells are burned for the manufacture of commercial air-slaked lime.

Examination of the stomach contents of fishes conducted in the College Limnological Station at Mayondon has shown that this clam is eaten by the food fishes found in Laguna de Bay. Not infrequently the meat of this bivalve is used as bait by the fishermen using *kitang* (hooks and lines).

Objects of the present work

The objects of the present work were: (*a*) To determine and compare the size-groups of the clam in Laguna de Bay and in Molawin Creek, Los Baños, with the end in view of gaining some idea as to its rate of growth; (*b*) to determine the approximate size at which the clam becomes sexually mature; (*c*) to determine the time and length of the spawning season. In addition to the above objects, a series of census was made to ascertain the approximate population of *C. manillensis* at different places in Molawin

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[1] Portions of the material embodied in this paper were included by the junior author in a thesis presented by him in 1930 for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture. Thesis, No. 318; Experiment Station contribution No. 679. Received for publication August 5, 1930.

Creek and at Mayondon, Laguna de Bay; and also to determine its altitudinal distribution in Molawin Creek.

Time and place of the present work

The work was begun in June, 1928, and ended in February, 1930. The clam samples were collected and the field observations made near the Los Baños Limnological Station at Mayondon.

MATERIALS AND METHODS

Field studies

Collecting and sampling of materials. All of the clams used in the present investigation were obtained from Laguna de Bay, at Mayondon, Los Baños, and from Molawin Creek, a tributary of the lake originating on Mount Maquiling. In Laguna de Bay, the collections were made by gathering the clams at a definite level along a stretch of clam bed which lay in a straight line perpendicular to the shore. Representative samples were obtained from all levels. During the high tide clam samples were secured by the use of a dredging net (fig. 1 and 2), a type of a gear which is generally used for gathering *tulla* in Laguna de Bay. Clam samples were also collected at random from piles of duck feed at Mayondon.

Collections in Molawin Creek were made on shallow strips of sandy banks. Care was taken during the entire period of observations that the clams collected were representative samples of the locality.

Determination of the approximate clam population. In determining the clam population, the clams per square meter at designated stations were counted. In Molawin Creek, an average of three counts was taken as the population of the station. Determination in this locality was made at different altitudes and at different times of the year.

Determination of length frequencies of the clams. The measurements of the clams were made just after they were collected. As the work required large quantities of material, the clams were returned to the water after they were measured.

The measurements were made with a sliding caliper reading directly to one-tenth of a millimeter. Only the length or the antero-posterior dimension was taken.[2]

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[2] WEYMOUTH, FRANK W. 1923. The life history and growth of Pismo clam, *Tivela stultorum* Mawe. California and Game Commission Bull. 7: 1–120. *Fig. 1–15.*

Weymouth measured the linear dimensions and the weight of a collection of two homogeneous series of clams of the same age so as to compare the coefficient of variability of lengths and weights. By comparing his results he found that length is more workable than weight. Theoretically, length is on an exact par with weight and practically more serviceable. Therefore in the present work it was considered safe to use length measurements only.

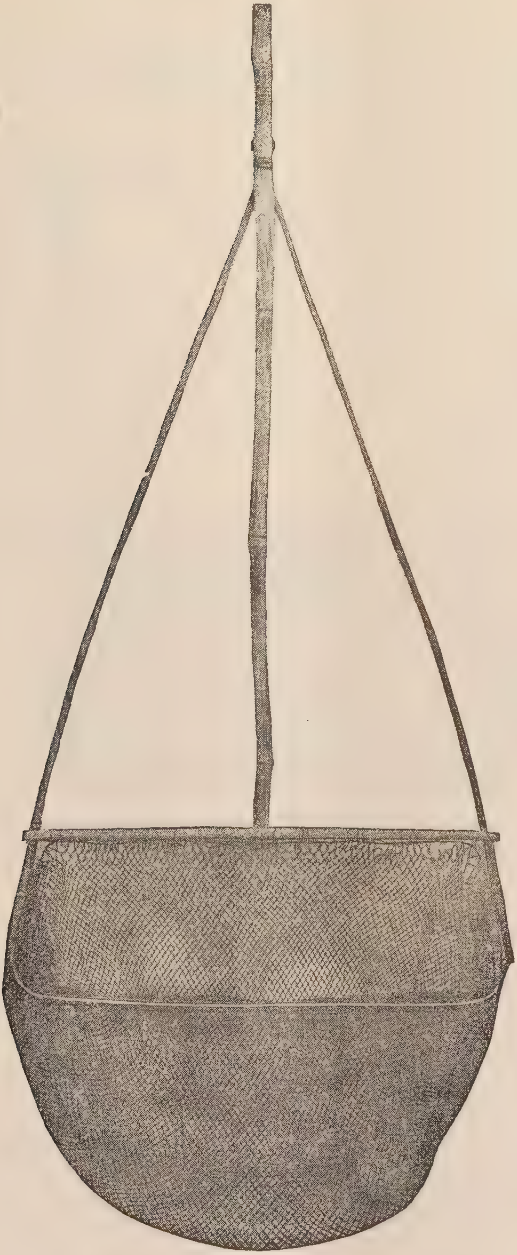

Fig. 1.—Dredge-net for collecting tulla (*Corbicula manillensis* Philippi) in shallow waters of Laguna de Bay. (Photograph by Photographic Division, College of Agriculture.)

Laboratory studies

Dissections of the clams and studies of the ova. A series of dissections of fresh clams was made by cutting open the visceral mass to ascertain the condition of the gonads. A portion of the gonads was teased out on a glass slide and the contents examined. Measurements of the ova were made with the aid of an eyepiece micrometer.

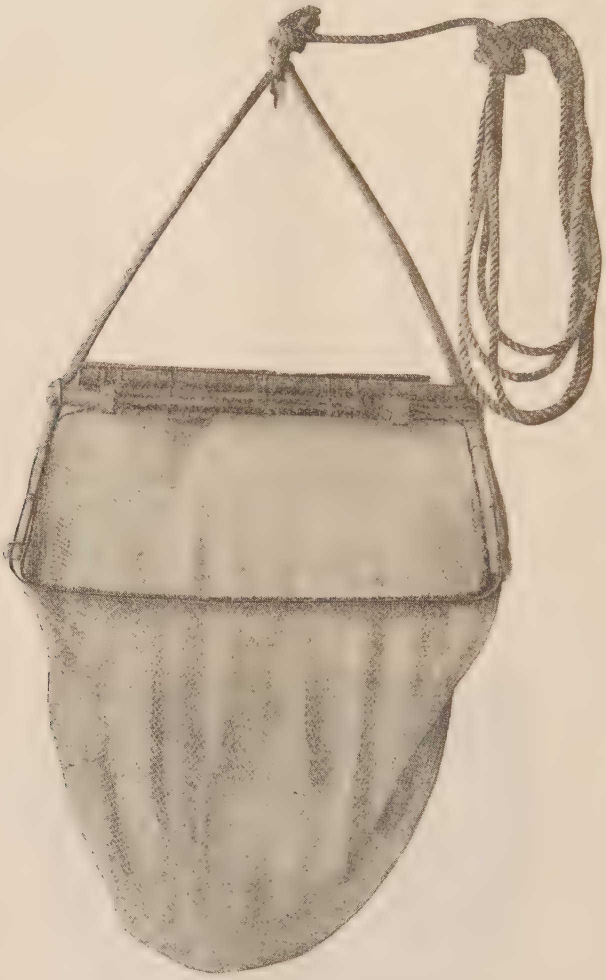

Fig. 2.—Dredge-net for collecting *tulla* (*Corbicula manillensis* Philippi) in the deeper waters of Laguna de Bay. (Photograph by Photographic Division, College of Agriculture.)

Study on sexual maturity. To determine the size at maturity, large numbers of fresh clams of different size-groups were examined. The smallest sexually mature individuals were set aside and measured.

RESULTS AND DISCUSSIONS

Size-groups of C. manillensis

As a basis for the determination of the rate of growth of *C. manillensis*, collections of representative samples were made at 30-day intervals from August, 1928, to November, 1929. The materials collected were measured and the measurements distributed into their respective frequency curves. By measuring large numbers of clams, it was possible to identify the modes corresponding to the various size-groups.

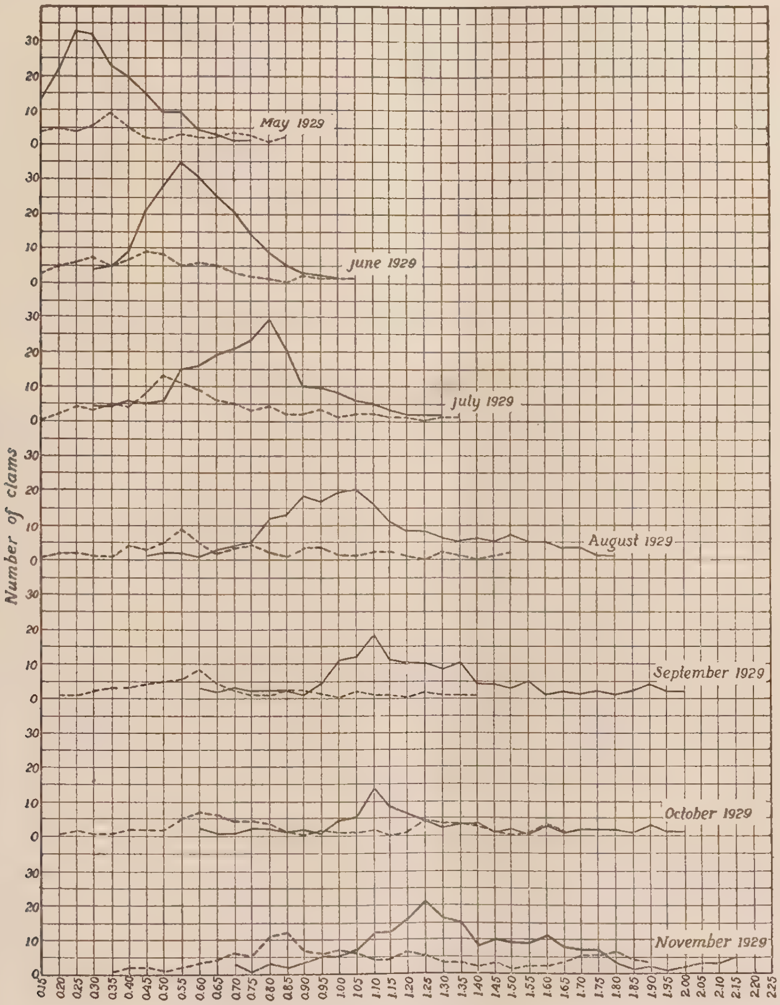

Chart 1.—Length frequencies of young clams from Laguna de Bay and Molawin Creek, May, 1929, to November, 1929. (Broken line, Molawin Creek; solid line, Laguna de Bay.)

Growth during the first year. A series of examinations of large numbers of mature clams collected in Laguna de Bay from January 5, 1928, to July 27, 1929, revealed the presence of masses of larvae and young embryos in the inter-lamellar spaces of the inner gills. (Tables 9 and 10; pl. I, fig. 12.) In Molawin Creek this condition was also shown in the collection made within the same period of time. The first collection of young clams used in growth determination was made on May 5 and on May 16, 1929, in Laguna de Bay and Molawin Creek, when clam samples taken from these localities showed for the first time during the year the presence of large numbers of young clams. Representative samples from Laguna de Bay and Molawin Creek were collected and measured at intervals of seven days. Chart 1 shows the length frequencies of clams measured from May 5 to November 31, 1929.

From chart 1 it may be seen that the clams collected in Laguna de Bay at Mayondon showed a progressive increase in growth during the period covered by the investigation, while those in Molawin Creek exhibited very little change.

Likewise, the collection in Laguna de Bay made in September, 1929, showed a very slight increase in the mode while that made in Molawin Creek did not show any appreciable change. On the other hand the collections made in October, 1929, showed no increase in the modes for either locality. The retardation in growth may have been due to the severe typhoon in the early part of September, 1929. It was not until November of the same year that the clams collected showed a slight increase both in the range of measurements and in their modes.

The rates of growth of the clams from May to November, 1929, can be traced in chart 1 by comparing the change of the lower and upper size limits of the clam measurements and from the various modes formed. It will be noted in chart 1 that clams in Laguna de Bay increased at a minimum rate of 0.15 cm., at a maximum rate of 0.33 cm., an average rate of 0.18 cm., and a modal rate of 0.87 cm. in the course of the seven months, from May, 1929, to November, 1929; whereas, the clams in Molawin Creek made increments at a minimum rate of 0.15 cm., a maximum rate of 0.30 cm., an average rate of 0.14 cm., and a modal rate of 0.55 cm. during the same period.

Growth during mature life. The clams used were secured from piles of duck feed. It was considered convenient and reliable to depend upon this source of materials as it was found that fishermen engaged in duck farming maintain the supply of the pile regularly from catches taken from practically the same locality. It was also repeatedly shown that the catches made by dredge-nets (fig. 1 and 2) which the fishermen use in collecting clams consisted of different size-groups. Chart 2 gives the length frequencies showing the size-groups of samples measured from November, 1928, to October, 1929. In table 2, the average and modal lengths of clams under the different size-groups are shown.

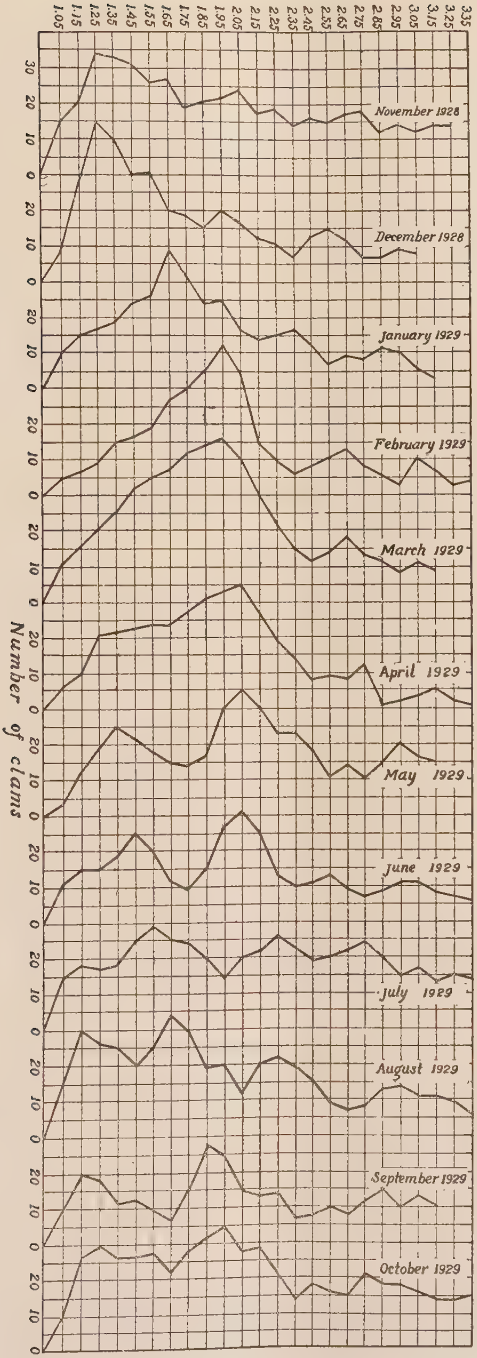

Chart 2.—Length frequencies of mature clams from Laguna de Bay, November, 1928, to October, 1929.

In the collections made during November, 1928, three size-groups were defined in the length frequency curves. Clams measuring from 1.05 to 1.75 cm. with a mode of 1.25 cm. tended to form a size-group. From what has been noted from the results of observations on the rate of growth of the clams, it is apparent that the clams attained a length of 2.25 cm. with an average of 1.40 cm. in seven months. It may, therefore, be concluded that the clams measuring from 1.05 to 1.75 cm. with a mode of 1.25 cm. properly belong to the first size-group; those measuring from 1.75 to 2.35 cm. with an average length of 2.05 cm. and a mode of 2.05 cm., to the second size-group; those measuring from 2.35 to 2.85 cm. with an average length of 2.60 cm. and a mode of 2.75 cm., to the third size-group. The subsequent size-groups are not defined in the frequency curves. The absence of a well-defined size class of clams older than group IV may be due either to the fact that the age limit is reached at the fourth size-group or that the clams have undergone depletion so that representatives of the fifth or older size-groups are so scarce that they do not become manifest in their respective size frequency curves.

In the collections made in December, the first size-group consisted of clams measuring from 1.05 to 1.85 cm. with a mode of 1.25 cm.; those measuring from 1.85 to 2.35 cm. with a mode of 1.95 cm. formed the second size-group; those measuring from 2.35 to 2.85 cm. with a mode of 2.55 cm., the third size-group.

The measurements made in January, 1928, showed a rapid increase in all the first, second, and third size-groups. In the first size-group the range was from 1.05 to 2.15 cm., with a mode of 1.65 cm.; in the second size-group, from 2.15 to 2.55 cm. with a mode of 2.35 cm.; in the third size-group, from 2.55 to 3.15 cm., with a mode of 2.85 cm.

Similar results were obtained in the collections made in February with change in modes as follows: First size-group, from 1.65 to 1.95 cm.; second size-group, from 2.15 to 2.65 cm.; third size-group, from 2.55 to 3.05 cm. In March none of the size-groups changed either in range of measurements or in modes.

In the April collections a slight change was noticed in the modes of the three size-groups: First size-group was from 1.95 to 2.05 cm.; second group, from 2.65 to 2.75 cm.; third group, from 3.05 to 3.15 cm. In this collection it was seen that a new frequency curve was formed before the first size-group. This may be accounted for by the appearance of young clams which developed from eggs spawned in July. The spawning season extends from February to July. As a matter of fact in table 10 are data on the finding of larvae in the gills of some clams in the collection made in July, 1929. The collections made in May showed the new frequency curve formed with a range of measurements from 1.05 to 1.75 cm. with a mode of 1.35 cm. The collections made in June produced similar results except that the modes of the first size-group increased from 1.35 to 1.45 cm. The collections made in July and August did not show any appreciable change in measurements except that a new frequency curve was formed with a mode of 1.15 cm. This new size-group must have been derived from broods which had hatched in January or February. In September the third and fourth size-groups registered a very slight increase in their modes. The first size-group increased from 1.15 to 1.25 cm., and the second size-group from 1.85 to 1.95 cm.

For the study of the rate of growth of mature clams in Molawin Creek, a sandy shallow bank where clams were found in abundance was selected. A lot, two meters by one meter, was fenced with number 15 wire netting. Representative samples of clams within this area were measured.

Chart 3 shows the length frequency curves formed by the measurements made at 30-day intervals from November, 1928, to May, 1929. From this chart, it may be seen that in all the measurements made, four size-groups were defined. The measurements made in November showed mode of 0.95 cm. for the first size-group; 1.35 cm. for the second; 1.85 cm. for third; and 2.25 cm. for fourth. From all indications it appears that the clams reached a maximum length of 1.9 cm. with an average length of 1.14

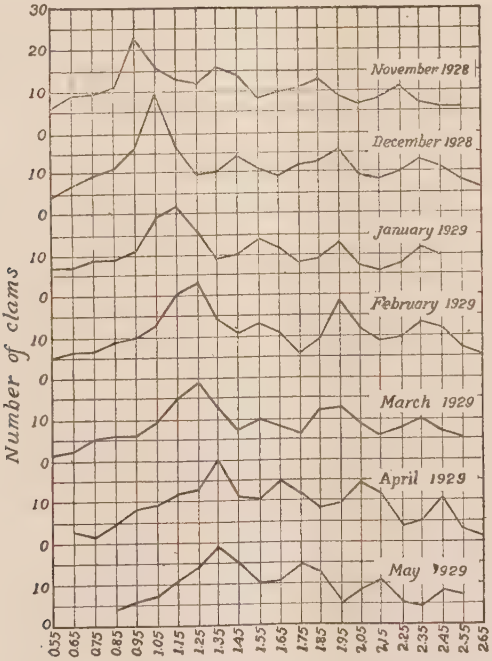

Chart 3.—Length frequencies of mature clams from Molawin Creek, November, 1928, to May, 1929.

cm. in seven months. Therefore, the clams measuring from 0.55 to 1.25 cm. long, with an average length of 0.9 cm. and a mode of 0.95 cm. may be said to compose the first size-group; those measuring from 1.25 to 1.5 cm. long, with an average length of 1.4 cm. and a mode of 1.35 cm., the second; those from 1.55 to 2.05 cm. long, with an average length of 1.80 cm. and a mode of 1.85 cm., the third; and those measuring from 2.05 to 2.65 cm. long, with an average length of 2.3 cm. and a mode of 2.25 cm., the fourth.

The measurements made in December showed an increase of 0.1 cm. in the modes of all the four size-groups, thus showing a slight increase in growth. In the measurements made in January, the first and second size-groups registered an increase in their modes while the third and fourth size-groups did not show any change. The measurements taken in February showed an increase in only the first size-group with no change in the older groups. The measurements made in March manifested the same condition as the measurements made in February. The measurements made in April showed an increase in all the modes of the four size-groups, while the measurements for May showed an increase in the modes of the third and fourth size-groups with no increase in the mode of the first size-group.

Sexual maturity

To determine the size at which the clam becomes sexually mature, large numbers of fresh clams were dissected and examined at intervals of seven days from December 6, 1928, to April 28, 1929. Each lot examined consisted of 100 clams representing different size-groups. The smallest sexually mature clams were separated from the rest and measured.

After repeated trials in opening the clams, a distinction between sexually mature clams and immature ones was noted. This distinction was based on the fact that just before spawning, well-developed gonads are present in mature individuals. In mature individuals which are recently spent, the gonads are large, but loose and shrunken. In immature individuals, the gonads appear to be translucent.

a. Size at maturity. Table 6 shows the size at maturity of clams examined from December 6, 1928, to April 28, 1929, at intervals of seven days.

The size at which the clams become sexually mature differed in the two localities. In Laguna de Bay the clams with an average length of 1.21 cm. were mature, while in Molawin Creek the clams became sexually mature at an average length of 1.03 cm. These figures correspond to the first size-group.

Spawning and breeding habits of C. manillensis

To determine the time and length of the spawning season of the *tulla*, collections and measurements of the ova and the larvae were begun before the time the clams are said to be "ripe", or "fat". The gonads during the

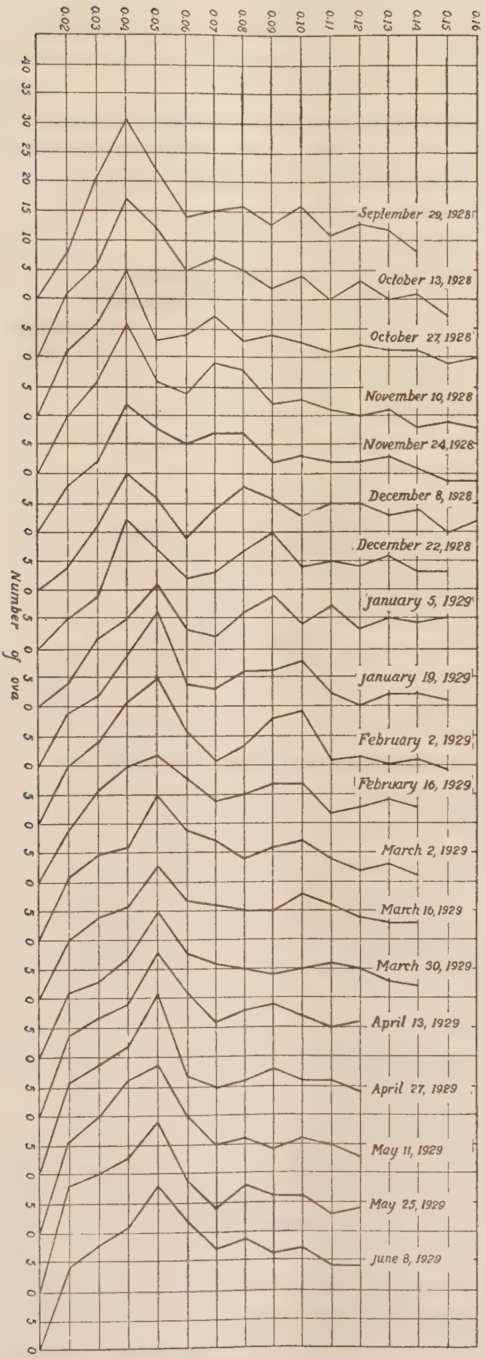

Chart 4.—Diameter frequencies of ova during period approaching spawning season, Laguna de Bay, September 29, 1928, to June 8, 1929.

pre-spawning season are not distended. The spawning clams, on the other hand, have gaping valves due apparently to the distension of the gonads within.

Spawning season in Laguna de Bay (Mayondon). Chart 4 shows the diameter frequencies of ova from clams collected in Laguna de Bay, and measured at fourteen-day intervals, from September 29, 1928, to June 8, 1929. The measurements were made between these dates because clams with larvae in the gills began to appear during January. Each curve is the result of measurements of 200 ova from 10 clams collected serially at random.

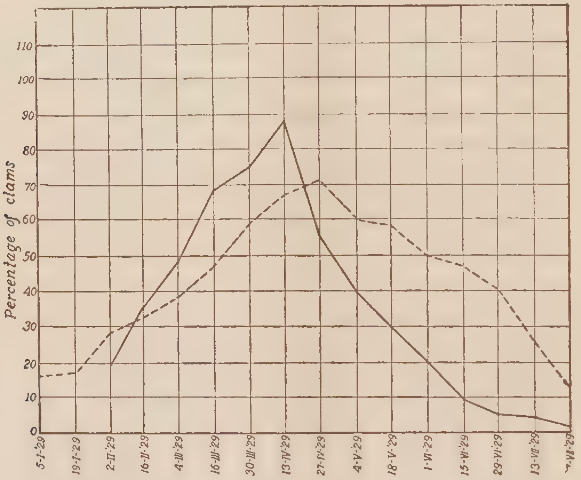

Chart 5.—Percentage of mature clams with larvae in the gills, Laguna de Bay and Molawin Creek from January 5, 1929, to July 27, 1929. (Broken line, Molawin Creek; solid line, Laguna de Bay.)

The measurements of clams made from September 29, 1928, to October 27, 1928, showed the presence of two kinds of ova, small and large, these are probably immature and mature ova.

The immature ova appear to be hexagonal when still in the follicles, owing to crowding. As soon as they are free they become rounded (pl. I, fig. 8). This group of ova measured from 20 to 60 μ and was observed to be present, soon after sexual maturity, in the clams at all periods.

Ova exceeding 60 μ were considered mature. These eggs appear to be pear-shaped (pl. I, fig. 9) with the nucleus and nucleolus within, clearly seen under the high power objective of the compound microscope.

An increase in the growth of ova was seen in the measurements made on November 4 and 18, 1928. The modal length of the immature ova increased from 40 to 50 μ. The mature ova also increased to an upper

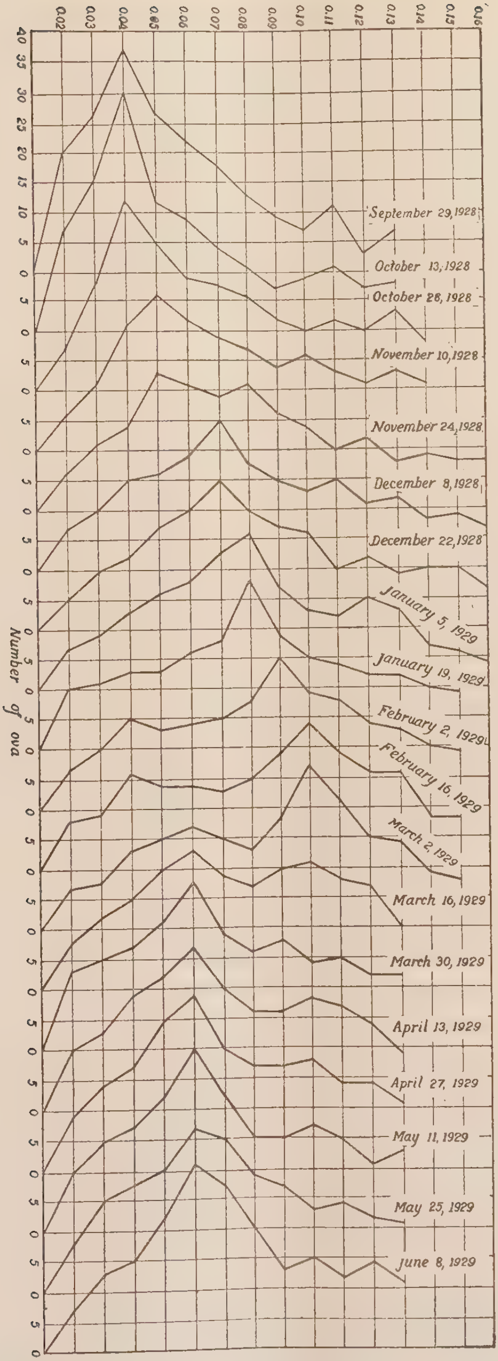

Chart 6.—Diameter frequencies of ova during period approaching spawning season, Molawin Creek, September 29, 1928, to June 8, 1929.

size limit of 160 μ. The measurements at subsequent dates showed a progressive increase of the immature ova until a diameter with a modal length of 80 μ was reached in the collections made on January 19, 1929. Larvae in the gills of clams were first noted in the collections made on February 2, 1929. It is very probable that spawning took place between January 11 and February 2, 1929 (see table 9).

In the measurements made on February 2, 1929, a new batch of immature ova was seen to be forming, nevertheless the modal length of the mature ova increases thus showing further growth. Measurements at subsequent dates showed that the newly formed generations of immature ova were fast increasing until on March 16, 1929, when a disappearance of large numbers of mature ova was noted. Again, the finding on March 30 of the same year of large numbers of clams with larvae in their gills showed that heavy spawning must have taken place between March 16, and 30, 1929 (see table 9 and chart 5). The measurements of ova made after March 16 showed the rapid disappearance of the mature ova while the immature remained persistent. In June there was a marked indication of a gradual slump of spawning activity until July when it was at an end as evidenced by the marked absence of larvae in the gills of clams examined (see table 9 and chart 6).

Spawning in Molawin Creek. The same method used in determining the spawning season of clams in Laguna de Bay was employed in the determination of the spawning season of clams in Molawin Creek. Measurements of the ova in The Molawin Creek clams were made during the same period as those of Laguna de Bay.

Chart 6 shows the diameter frequencies of ova measured at fourteen-day intervals during a period from September 29, 1928, to June 8, 1929. It may be seen from this chart that mature ova began to disappear after December 8, 1928. In table 10 it is shown that clams with larvae in the gills began to appear January 5, 1930; this indicates that the clams probably began spawning between December 22, 1928, and January 5, 1929.

On April 13, 1929, a marked disappearance of mature ova was noted. Two weeks later (week ending April 27, 1929) the highest percentage of clams with larvae in the gills was obtained from regular examination of samples (see table 10 and chart 6). This finding may be interpreted to mean that the peak of spawning activity took place between April 13 and 27, 1929.

Like *C. manillensis* in Laguna de Bay, that of the Molawin Creek exhibited a marked indication of gradual decrease in spawning activity commencing in June and continuing until July when spawning was apparently at an end.

Approximate population of the clams in Laguna de Bay

In determining the approximate population of the clams, the number of clams per square meter was determined at designated stations. The counting was made on ten stations (each station being ten meters apart) starting from the shore line.

Chart 7 shows the results of the census of the beds at 30-day intervals from March, 1929, to February, 1930. It may be seen from chart 7 that from ten counts the average number a square meter in March, 1929, was found to be 136. In April the average number a square meter was 132. The counts made in May gave an average number of 204 a square meter. This increase in population may be explained as due to the abundant set in May. Subsequent counts made from June to August, as indicated by the figures, showed a progressive decrease in the population until in September when a very marked decrease was noticed. By September and October the clams had been reduced to more than one-third of the number obtained at the first counting. In September, the severe typhoon greatly disturbed the beds and rendered conditions unfavorable for the clams.

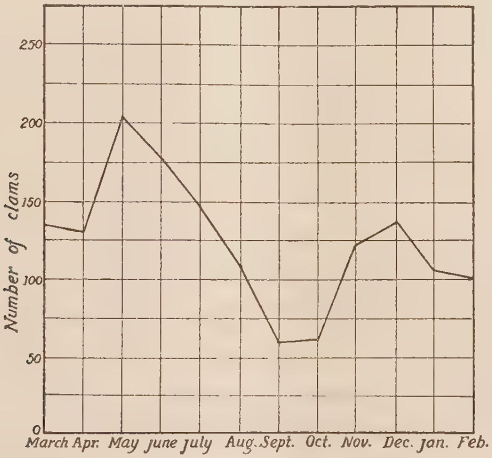

Chart 7.—Approximate number of clams per square meter, Laguna de Bay, March, 1929, to February, 1930.

The census taken after October showed a slight increase in the average population per square meter, probably the result of subsequent addition of other clams that had been carried in from other parts of the lake by strong water currents.

Approximate population and altitudinal distribution of C. manillensis in Molawin Creek

Table 12 shows the average number of clams to a square meter at different altitudes. It is shown in this table that at lower elevations, the clams were more numerous than at higher altitudes. At an elevation of 103.3 meters and above the clams ceased to exist. This progressive decrease in population seems to indicate that clams from higher levels are constantly brought to the lower levels by the running water. Or it may be that the slow process of adaptation has not yet enabled this clam to live at higher altitudes. Cooke (1895)[3] called attention to the fact that *Corbicula* has been derived from the exclusively marine Veneridae. Moreover, lack of suitable breeding places may probably account for the complete absence of *tulla* in the higher altitudes, as in these elevations the bed of the creek is made up of hard rocks and large boulders.

SUMMARY AND CONCLUSIONS

1. The *tulla* is the only bivalve that is gathered in quantities approaching a commercial scale in Laguna de Bay and its tributaries. It is extensively used as feed for *itek* (domesticated ducks, *Anas boschas* Linn.), and forms part of the diet of the inhabitants of the region, especially of the laboring class.

2. The present work is an attempt to determine and compare the rate of growth of the clam in Laguna de Bay and in Molawin Creek, Los Baños, from the time the larvae are expelled from the gills of the clams until they become sexually mature and a few years older; to determine the time and length of the spawning season; to determine the approximate population of the clam in Laguna de Bay at Mayondon; and to determine the altitudinal distribution of the clam in Molawin Creek.

3. In the course of seven months, from May to November, 1929, the young clams in Laguna de Bay were found to increase at a minimum group rate of 0.15 cm. or at a maximum group rate of 0.33 cm., or at an average group rate of 0.18 cm.; the clam in Molawin Creek made increments at a minimum group rate of 0.15 cm., or at a maximum group rate of 0.30 cm., or at an average group rate of 0.14 cm. during the same period.

4. In the length frequency measurements of clams taken from piles of duck feed in Laguna de Bay at Mayondon, three distinct size-groups were defined and in Molawin Creek, four.

5. The average length of clams in both Laguna de Bay and in Molawin Creek belonging to the different size-groups was calculated to be as follows:

Size-groups	*Average length in Laguna de Bay cm.*	*Average length in Molawin Creek cm.*
I	1.44	1.07
II	2.17	1.58
III	2.75	1.96
IV	3.05	2.30

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[3] Cooke, A. A., A. E. Shipley, and F. R. Reed. 1895. Molluscs and Brachiopoda. xi+1535 p., 344 fig. London: Macmillan and Company.

6. The average rate of increment of clams belonging to the different size groups was calculated as follows:

Size-groups	*Length in Laguna de Bay cm.*	*Length in Molawin Creek cm.*
I	1.42	1.05
II	0.73	0.51
III	0.58	0.38
IV	0.30	0.34

7. The clams attain sexual maturity in Laguna de Bay at an average length of from 1.21 to 1.75 cm.; in Molawin Creek at from 1.03 to 1.25 cm. Clams of this size belong to size-group I.

8. The small, probably immature ova, are hexagonal when still in the follicles. They measure from 20μ to 60μ in diameter. The large, probably mature ova, appear to be pear-shaped with a distinct nucleus and nucleolus. They measure from 70μ to 160 μ at widest diameter.

9. The spawning season of the *tulla*, as indicated by the presence of larvae in the gills, was found to cover a period of from the first week of February to the last week of July in Laguna de Bay, and from the first week of January to the last week of July in Molawin Creek.

10. The peak of spawning activity of *tulla* was shown to take place during the last two weeks of March in Laguna de Bay and during the middle of April in Molawin Creek.

11. The average number of clams per square meter in Laguna de Bay varied from 62 (September, 1928), to 204 (May, 1929).

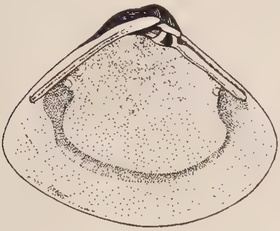
12. The clam population in Molawin Creek was found to decrease with increase in elevation up to an altitude of 103.3 meters and above, when it ceased altogether.

13. From a careful examination of the facts obtained from the study of the biology of *C. manillensis*, it appears that legislative measures which may be recommended for the proper conservation of this species of economic bivalve are quite simple. The dredge-nets which are used by clam collectors should have mesh-openings of at least 2.5 cm., stretched. This will allow the easy passage of small clams which are still immature or which are just spawning for the first time. The mesh-openings of the bags now used are only about two millimeters stretch, hence, the dredge-nets collect even the newly hatched *tulla*. It is also recommended that a thorough survey of the spawning grounds of the *tulla* be effected with the end in view of closing such areas to clam or snail collectors at certain seasons. February, March, and April of each year should be declared a closed season as it is in this period that the clams are heavily spawning. Such a law would protect the broods and young from unnecessary disturbance and destruction.

EXPLANATION OF PLATE

(Drawings by Daniel M. Buñag)

Fig. 1. *Corbicula manillensis* Philippi, left valve, × 2.
Fig. 2. *C. manillensis*, posterior end showing siphons, × 2.
Fig. 3. *C. manillensis*, right valve, ental aspect, × 2.
Fig. 4. *C. manillensis*, left valve removed to show mantle, × 2.
Fig. 5. *C. manillensis*, left valve and mantle removed, × 2.
Fig. 6. *C. manillensis*, left gills pushed back to show gonads, × 2.
Fig. 7. *C. manillensis*, dissected to show digestive system, × 2.
Fig. 8. Immature egg of *C. manillensis*. Very highly magnified.
Fig. 9. Mature egg of *C. manillensis*. Very highly magnified.
Fig. 10. Spermatozoa of *C. manillensis*. Very highly magnified.
Fig. 11. Larva of *C. manillensis* at the age of extrusion. Very highly magnified.
Fig. 12. Portion of inner gills, showing nepionic shells. Very highly magnified.



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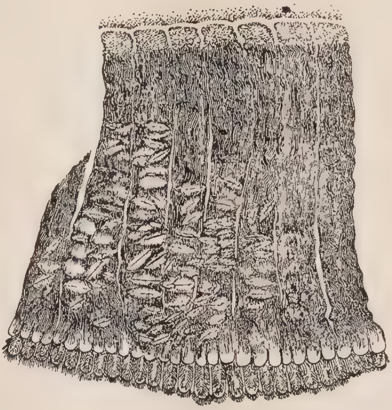

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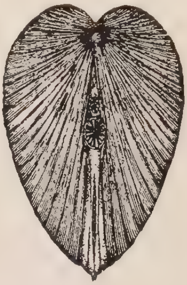

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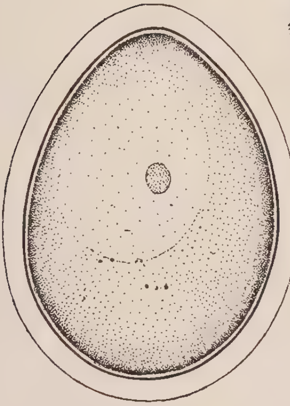

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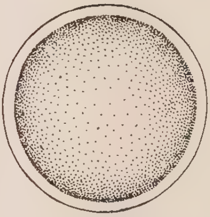

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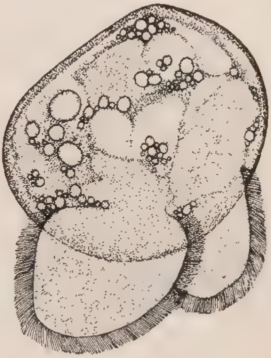

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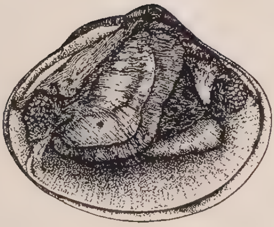

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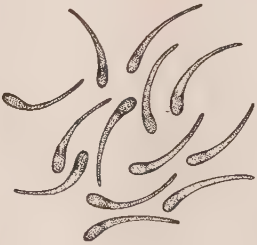

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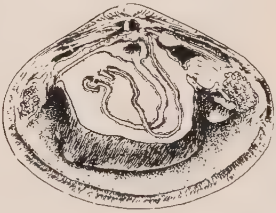

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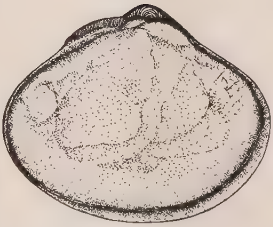

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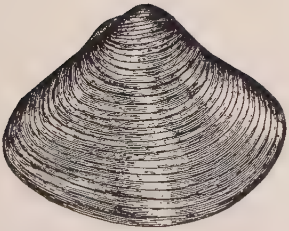

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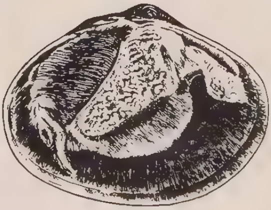

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Plate I

TABLE 1

Length frequencies of young clams [a]

LENGTH OF CLAM	LENGTH FREQUENCY													
	May		June		July		August		September		October		November	
	Mayon-don	Molawin Creek	Mayon-don	Molawin Creek	Mayon-don	Molawin Creek	Mayon-don	Molawin Creek	Mayon-don	Molawin Creek	Mayon-don	Molawin Creek	Mayon-don	Molawin Creek
cm.														
0.16—0.20	13	4	0	3	0	1	0	1	0	0	0	0	0	0
0.21—0.25	22	5	0	5	0	2	0	2	0	1	0	1	0	0
0.26—0.30	33	4	0	6	0	4	0	2	0	1	0	2	0	0
0.31—0.35	32	6	3	7	4	3	0	1	0	2	0	1	0	0
0.36—0.40	23	9	5	5	4	5	0	1	0	3	0	1	0	1
0.41—0.45	20	5	9	7	6	4	0	4	0	3	0	2	0	2
0.46—0.50	15	2	21	9	5	3	1	3	0	4	0	2	0	2
0.51—0.55	9	1	28	8	6	13	2	5	0	5	0	2	0	1
0.56—0.60	9	3	35	5	15	11	2	9	0	6	0	5	0	2
0.61—0.65	4	2	31	6	16	9	1	5	3	8	2	7	0	3
0.66—0.70	3	2	26	5	19	6	2	2	2	4	1	6	0	4
0.71—0.75	1	3	21	3	21	5	4	3	3	2	1	4	3	6
0.76—0.80	1	2	14	2	23	3	5	4	2	1	2	4	1	5
0.81—0.85	0	1	10	1	29	4	12	2	2	1	2	3	3	11
0.86—0.90	0	2	8	0	21	2	13	1	2	2	1	1	2	12
0.91—0.95	0	0	5	2	10	2	18	3	1	2	2	0	3	7
0.96—1.00	0	0	3	1	9	3	17	3	4	1	1	2	5	6
1.01—1.05	0	0	2	1	8	1	19	1	11	0	4	1	5	7
1.06—1.10	0	0	1	1	6	2	20	1	12	2	5	1	7	6
1.11—1.15	0	0	0	0	5	2	16	2	18	1	14	2	12	4
1.16—1.20	0	0	0	0	3	1	11	2	11	1	8	0	12	4
1.21—1.25	0	0	0	0	2	1	8	1	10	0	6	1	16	6
1.26—1.30	0	0	0	0	1	0	8	0	10	2	4	4	21	5
1.31—1.35	0	0	0	0	1	1	6	2	8	1	2	3	16	3
1.36—1.40	0	0	0	0	1	1	5	1	10	1	3	3	15	3
1.41—1.45	0	0	0	0	0	0	6	0	4	1	3	2	8	2
1.46—1.50	0	0	0	0	0	0	5	1	4	0	1	1	10	3
1.51—1.55	0	0	0	0	0	0	7	2	3	0	2	0	9	1
1.56—1.60	0	0	0	0	0	0	5	0	5	0	1	1	9	2
1.61—1.65	0	0	0	0	0	0	5	0	1	0	3	3	11	2
1.66—1.70	0	0	0	0	0	0	3	0	2	0	1	1	8	3
1.71—1.75	0	0	0	0	0	0	3	0	1	0	2	0	7	5
1.76—1.80	0	0	0	0	0	0	2	0	2	0	2	0	7	5
1.81—1.85	0	0	0	0	0	0	2	0	1	0	1	0	3	6
1.86—1.90	0	0	0	0	0	0	0	0	2	0	3	0	1	4
1.91—1.95	0	0	0	0	0	0	0	0	3	0	1	0	2	3
1.96—2.00	0	0	0	0	0	0	0	0	1	0	1	0	3	0
2.01—2.05	0	0	0	0	0	0	0	0	1	0	0	0	3	0
2.06—2.10	0	0	0	0	0	0	0	0	2	0	0	0	5	0
2.11—2.15	0	0	0	0	0	0	0	0	1	0	0	0	5	0
2.16—2.20	0	0	0	0	0	0	0	0	0	0	0	0	4	0
Total number clams measured	185	51	222	77	215	94	209	64	140	55	81	65	216	136

[a] Based on measurements at 30-day intervals from May to November, 1929. Clams collected from two sources—Molawin Creek and Laguna de Bay.

TABLE 2

Length frequencies of mature clams [a]

LENGTH OF CLAMS	LENGTH FREQUENCY											
	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.
cm.												
1.01—1.10	15	8	10	5	11	6	3	11	14	16	10	11
1.11—1.20	21	28	15	7	16	10	13	15	18	30	20	27
1.21—1.30	34	45	17	9	20	20	19	15	17	26	18	30
1.31—1.40	33	40	19	15	25	21	25	18	18	25	12	27
1.41—1.50	31	30	24	17	32	22	22	25	25	20	13	27
1.51—1.60	16	31	26	19	35	23	18	20	29	25	10	28
1.61—1.70	27	20	39	27	37	23	15	12	25	34	7	22
1.71—1.80	19	18	32	30	42	27	14	9	24	30	16	28
1.81—1.90	21	15	24	35	44	31	22	15	20	19	28	32
1.91—2.00	22	20	25	42	46	33	30	27	14	20	25	35
2.01—2.10	24	17	17	35	40	35	35	31	20	12	15	28
2.11—2.20	18	12	14	15	30	27	30	25	22	20	13	29
2.21—2.30	19	11	15	9	23	19	23	13	26	22	14	21
2.31—2.40	14	7	17	6	15	14	23	10	23	19	7	14
2.41—2.50	16	13	13	8	12	8	18	11	19	16	8	18
2.51—2.60	15	15	7	10	14	9	11	13	20	9	10	16
2.61—2.70	17	12	9	13	18	8	14	9	22	7	8	15
2.71—2.80	18	7	8	8	13	12	10	7	24	8	12	21
2.81—2.90	12	7	11	6	12	1	14	9	20	13	15	18
2.91—3.00	14	9	10	4	8	2	20	11	15	14	10	18
3.01—3.10	12	8	6	10	11	3	17	11	17	11	8	16
3.11—3.20	14	0	3	7	9	5	15	8	13	11	5	14
3.21—3.30	14	0	0	3	0	2	0	7	15	9	0	14
3.31—3.40	0	0	0	4	0	1	0	6	14	6	0	15
Total number of clams measured...	446	378	351	344	511	362	411	338	471	420	284	524

[a] Based on measurements at 30-day intervals from November, 1928, to October, 1929. Clams collected from piles of duck feed in Laguna de Bay.

TABLE 3

Average and modal lengths of clams in Laguna de Bay under different size-groups

SIZE GROUPS	NOVEMBER Mode	NOVEMBER Av. of range	DECEMBER Mode	DECEMBER Av. of range	JANUARY Mode	JANUARY Av. of range	FEBRUARY Mode	FEBRUARY Av. of range	MARCH Mode	MARCH Av. of range	APRIL Mode	APRIL Av. of range	AVERAGE Mode	AVERAGE Av. of range
	cm.	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
I	1.25	1.30	1.25	1.35	1.65	1.60	1.95	1.70	1.95	1.75	1.25	1.35	1.43	1.44
II	2.05	2.05	1.95	2.00	2.35	2.35	2.65	2.65	2.65	2.20	2.05	2.05	2.13	2.17
III	2.75	2.60	2.55	2.60	2.85	2.85	3.05	3.10	3.05	3.15	2.75	2.65	2.59	2.75
IV	—	—	—	—	—	—	—	—	—	—	3.25	3.10	3.05	3.05

SIZE GROUPS	MAY Mode	MAY Av. of range	JUNE Mode	JUNE Av. of range	JULY Mode	JULY Av. of range	AUGUST Mode	AUGUST Av. of range	SEPTEMBER Mode	SEPTEMBER Av. of range	OCTOBER Mode	OCTOBER Av. of range	AVERAGE Mode	AVERAGE Av. of range
	cm.	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
I	1.35	1.40	1.45	1.40	1.55	1.50	1.15	1.25	1.15	1.35	1.25	1.35	1.43	1.44
II	2.05	2.75	2.05	2.05	2.25	2.25	1.65	1.75	1.85	2.00	1.95	2.00	2.13	2.17
III	2.95	2.95	2.55	2.55	2.75	2.85	2.25	2.35	2.85	2.75	2.75	2.80	2.59	2.75
IV	—	—	2.95	3.05	—	—	2.95	3.00	—	—	—	—	3.05	3.05

TABLE 4

Length frequencies of mature clams[a]

LENGTH OF CLAM	LENGTH FREQUENCY						
	Nov.	Dec.	Jan.	Feb.	March	April	May
cm.							
0.51—0.60...	6	4	7	5	2	0	0
0.61—0.70...	9	7	7	7	3	3	0
0.71—0.80...	9	9	9	7	5	2	0
0.81—0.90...	11	11	9	9	6	5	4
0.91—1.00...	23	16	11	10	6	8	6
1.01—1.10...	16	29	19	13	9	9	7
1.11—1.20...	13	17	22	20	15	12	11
1.21—1.30...	12	9	16	23	19	13	14
1.31—1.40...	16	10	9	14	13	20	19
1.41—1.50...	14	14	10	11	7	11	15
1.51—1.60...	8	11	14	13	10	10	10
1.61—1.70...	10	9	12	11	8	15	11
1.71—1.80...	11	12	8	6	6	12	14
1.81—1.90...	13	13	9	9	12	8	13
1.91—2.00...	9	16	13	18	13	9	5
2.01—2.10...	7	9	7	12	9	14	8
2.11—2.20...	8	8	6	9	6	12	11
2.21—2.30...	11	10	8	10	8	4	5
2.31—2.40...	7	13	12	13	10	5	4
2.41—2.50...	6	11	10	12	7	10	8
2.51—2.60...	6	8	5	7	5	3	7
2.61—2.70...	0	6	0	5	0	1	5
Total........	225	252	223	234	179	183	177

[a] Based on measurements at 30-day intervals from November 1928 to April 1929. Clams collected in Molawin Creek.

TABLE 5

Average and modal lengths of clams in Molawin Creek under different size-groups

SIZE GROUPS	NOVEMBER		DECEMBER		JANUARY		FEBRUARY		MARCH		APRIL		MAY		AVERAGE	
	Mode	Av. of range	Mode	Av. of range	Mode	Av. of range	Mode	Av. of range	Mode	Av. of range	Mode	Av. of range	Mode	Av. of range	Mode	Av. of range
	cm.	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
I	.95	.90	1.05	.90	1.15	.95	1.25	1.00	1.25	1.00	1.35	1.10	1.35	1.70	1.19	1.07
II	1.35	1.40	1.45	1.45	1.55	1.55	1.55	1.60	1.55	1.60	1.65	1.70	1.75	1.75	1.55	1.58
III	1.85	1.80	1.95	1.90	1.95	1.95	1.95	1.95	1.95	1.95	2.15	2.05	2.15	2.15	1.86	1.96
IV	2.25	2.30	2.35	2.40	2.35	2.35	2.35	2.40	2.35	2.35	2.45	2.45	2.45	2.50	2.22	2.30

TABLE 6

Minimum, maximum, and average lengths of immature and mature clams[a]

DATE	NUMBER OF CLAMS EXAMINED		IMMATURE						MATURE					
			Laguna de Bay			Molawin Creek			Laguna de Bay			Molawin Creek		
	Laguna de Bay	Molawin Creek	Min. length	Max. length	Av. length	Min. length	Max. length	Av. length	Min. length	Max. length	Av. length	Min. length	Max. length	Av. length
1928			*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
2–XII..	100	100	0.70	1.10	0.85	0.54	0.99	0.74	0.92	1.90	1.34	0.95	1.68	1.04
9–XII..	100	100	0.79	1.05	0.97	0.73	1.08	0.78	1.15	1.86	1.21	0.98	1.33	0.99
16–XII..	100	100	0.83	0.97	0.85	0.81	1.01	0.85	0.98	1.72	1.09	1.04	1.52	1.07
23–XII..	100	100	0.75	1.01	0.79	0.57	0.99	0.72	1.25	1.45	1.31	1.00	1.90	1.06
30–XII..	100	100	0.92	1.07	0.95	0.83	0.95	0.84	1.21	2.03	1.23	1.12	1.70	1.18
1929														
6–I....	100	100	0.87	1.20	0.94	0.70	0.87	0.73	1.17	1.85	1.21	0.95	1.98	0.98
13–I....	100	100	0.80	1.19	0.89	0.72	1.00	0.76	0.99	1.79	1.03	1.13	1.73	1.21
20–I....	100	100	0.93	1.13	1.02	0.87	1.07	0.86	1.20	1.93	1.27	1.06	2.00	1.09
27–I....	100	100	0.90	1.23	1.07	0.62	0.88	0.72	1.16	2.01	1.17	0.97	1.60	0.99
3–II...	100	100	0.71	1.09	0.85	0.80	1.03	0.82	1.08	1.86	1.31	0.94	1.82	0.95
10–II...	100	100	0.83	1.11	0.87	0.69	0.86	0.72	1.01	1.56	1.41	0.90	1.42	0.91
17–II...	100	100	0.89	1.07	0.90	0.82	0.94	0.84	1.00	1.76	1.08	0.98	1.61	0.99
24–II....	100	100	0.92	1.00	0.94	0.88	1.00	0.89	1.27	2.01	1.33	1.03	1.52	1.04
3–III...	100	100	0.89	1.02	0.92	0.52	0.99	0.72	1.20	1.71	1.27	0.97	1.72	0.98
10–III...	100	100	0.97	1.13	0.98	0.83	1.02	0.85	1.00	2.00	1.11	1.01	1.45	1.02
17–III...	100	100	0.90	1.20	0.93	0.79	0.90	0.81	1.21	1.82	1.24	1.11	1.86	1.13
24–III...	100	100	0.85	0.99	0.86	0.67	1.11	0.72	1.03	2.07	1.18	1.00	1.38	1.01
31–III...	100	100	0.81	0.88	0.83	0.59	0.96	0.64	1.09	1.76	1.15	1.16	2.21	1.17
7–IV...	100	100	0.77	1.21	0.79	0.87	0.98	0.89	1.00	1.50	1.15	1.05	1.93	1.06
14–IV...	100	100	0.89	1.02	0.92	0.68	0.89	0.71	1.23	2.06	1.31	0.93	1.77	0.94
21–IV...	100	100	0.78	1.25	0.80	0.81	0.97	0.82	1.29	2.06	1.21	1.05	2.11	1.06
28–IV...	100	100	0.91	1.19	0.93	0.66	1.04	0.72	1.06	1.90	1.21	0.98	1.65	0.99
Minim..	—	—	0.71	0.88	—	0.52	0.86	—	0.92	1.50	—	0.93	—	—
Maxim..	—	—	0.97	1.23	—	0.88	1.11	—	1.29	2.07	—	1.16	—	—
Average.	—	—	0.84	1.09	0.90	0.72	0.97	0.78	1.11	1.84	1.21	1.01	1.67	1.03

[a] Based on determinations at 7-day intervals from December 6, 1928, to April 28, 1929. Clams collected from two sources, Laguna de Bay and Molawin Creek.

TABLE 7

Diameter frequencies of ova during period approaching spawning season [a]

OVA DIAMETER	DIAMETER FREQUENCIES																	
	1928							1929										
	29-IX	13-X	27-X	10-XI	24-XI	8-XII	22-XII	5-I	19-I	2-II	16-II	4-III	16-III	30-III	13-IV	27-IV	4-V	18-V	1-VI
mm.																			
0.01—0.02	20	1	7	6	6	7	5	7	10	7	8	7	8	13	10	9	10	8	7
0.02—0.03	26	25	18	11	11	10	10	9	11	10	9	8	12	15	13	14	15	15	13
0.03—0.04	37	40	32	21	14	15	12	13	13	15	16	13	15	17	19	17	17	18	15
0.04—0.05	27	22	25	26	23	16	17	16	13	13	14	15	20	21	22	25	22	20	22
0.05—0.06	22	19	19	22	21	19	20	18	16	14	14	17	23	28	28	29	30	27	31
0.06—0.07	18	14	18	19	19	25	23	23	18	15	13	15	19	19	20	20	23	25	27
0.07—0.08	13	11	16	17	21	18	20	26	28	18	15	13	17	16	16	17	15	19	20
0.08—0.09	9	7	12	14	16	15	17	18	19	25	19	18	20	18	18	18	17	17	13
0.09—0.10	7	9	10	16	14	13	16	13	15	19	25	27	21	14	15	12	13	13	15
0.10—0.11	11	11	12	13	10	15	10	12	14	18	19	21	18	15	17	14	15	14	12
0.11—0.12	3	7	10	11	12	11	12	15	12	14	16	15	17	12	14	14	11	12	14
0.12—0.13	7	8	13	13	8	12	9	13	12	13	16	14	10	12	9	11	13	11	11
0.13—0.14	0	0	8	11	9	8	10	7	10	10	8	9	0	0	0	0	0	0	0
0.14—0.15	0	0	0	0	8	9	10	6	9	9	8	8	0	0	0	0	0	0	0
0.15—0.16	0	0	0	0	8	7	7	4	0	0	0	0	0	0	0	0	0	0	0
Total	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200

[a] Measured at 14-day intervals; ova from ten clams from Laguna de Bay considered in each measurement.

TABLE 8

Diameter frequencies of ova during period approaching spawning season[a]

OVA DIAMETER	DIAMETER FREQUENCIES																				
	1928							1929													
	29-IX	13-X	27-X	10-XI	24-XI	8-XII	22-XII	5-I	19-I	2-II	16-II	4-III	16-III	30-III	13-IV	27-IV	4-V	18-V	1-VI
mm.																			
0.01—0.02	8	11	11	9	8	4	5	4	9	10	9	11	10	11	14	16	16	18	14
0.02—0.03	21	16	16	16	12	11	9	12	12	14	16	15	14	13	17	19	20	20	18
0.03—0.04	31	27	25	26	22	20	22	15	19	21	20	16	16	17	19	22	26	23	21
0.04—0.05	22	22	13	16	18	16	17	21	26	25	22	25	23	25	28	31	29	29	28
0.05—0.06	14	15	14	14	15	9	12	13	14	16	18	19	17	18	21	17	20	19	22
0.06—0.07	15	17	17	19	17	14	13	12	13	11	14	17	16	16	16	15	15	14	17
0.07—0.08	16	15	13	18	17	18	17	16	16	13	15	14	15	15	18	16	16	18	19
0.08—0.09	13	12	14	12	12	16	20	19	16	18	17	16	15	14	19	18	14	16	16
0.09—0.10	16	14	13	13	13	13	14	14	18	19	17	17	18	15	17	16	16	16	17
0.10—0.11	11	10	11	11	12	15	15	17	12	11	12	14	16	16	15	16	15	13	14
0.11—0.12	13	13	12	10	12	15	14	13	10	12	13	12	14	15	16	14	13	14	14
0.12—0.13	12	10	11	11	13	13	16	15	12	10	14	13	13	13	0	0	0	0	0
0.13—0.14	8	11	11	8	11	14	13	14	12	11	13	11	13	12	0	0	0	0	0
0.14—0.15	0	7	9	9	9	10	14	15	16	9	0	0	0	0	0	0	0	0	0
0.15—0.16	0	0	10	8	9	12	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200

[a] Measured at 14-day intervals; ova from ten clams from the Molawin Creek considered in each measurement.

TABLE 9

Percentage of spawning clams in Laguna de Bay at different months [a]

DATE	NUMBER OF CLAMS EXAMINED	NUMBER OF CLAMS WITH LARVAE IN GILLS	PERCENTAGE OF CLAMS WITH LARVAE IN GILLS
1929			
5–I	133	—	—
19–I	128	—	—
2–II	153	29	18.95
16–II	149	53	35.56
4–III	162	78	48.14
16–III	182	127	69.67
30–III	193	144	74.61
13–IV	187	167	89.30
27–IV	180	91	50.55
4–V	173	69	39.87
18–V	162	48	29.62
1–VI	184	33	20.32
15–VI	155	15	9.66
29–VI	141	8	5.67
13–VII	111	5	4.50
27–VII	126	3	2.30

[a] Spawning was judged by presence of larvae on gills. Measurements made at 14-day intervals.

TABLE 10

Percentage of spawning clams in Molawin Creek at different months [a]

DATE	NUMBER OF CLAMS EXAMINED	NUMBER OF CLAMS WITH LARVAE IN GILLS	PERCENTAGE OF CLAMS WITH LARVAE IN GILLS
1929			
5–I	83	14	16.86
19–I	113	13	17.71
2–II	93	27	29.06
16–II	67	21	31.34
4–III	111	43	38.72
16–III	82	39	47.56
30–III	79	46	58.22
13–IV	83	56	67.46
27–IV	110	78	70.90
4–V	91	55	60.43
18–V	103	60	58.25
1–VI	89	45	50.66
15–VI	76	36	47.36
29–VI	98	40	40.81
13–VII	72	18	25.00
27–VII	91	11	12.08

[a] Spawning was judged by presence of larvae on gills. Measurements made at 14-day intervals.

TABLE 11

Approximate number of clams per square foot of clam bed in Laguna de Bay, March, 1929, to February, 1930

STATION NO.	1929										1930	
	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
1	70	89	150	160	98	47	39	63	89	65	59	25
2	84	106	192	156	136	74	69	79	81	83	77	33
3	107	137	211	126	104	99	59	105	114	160	152	106
4	134	156	210	177	135	107	90	98	122	154	152	149
5	155	167	259	223	163	143	98	104	124	159	137	148
6	164	162	178	213	179	145	95	98	134	179	126	161
7	168	154	204	186	155	145	55	61	135	184	102	108
8	135	120	225	192	131	120	42	48	133	152	104	101
9	150	130	197	170	155	100	45	47	75	113	85	94
10	175	106	222	182	180	125	36	29	125	144	69	82
Average	136	132	204	178	147	110	62	63	124	139	106	100

TABLE 12

Approximate population and altitudinal distribution of the clams in the Molawin Creek, May 1929, August 1929, and January 1930

STATION NO.	ALTITUDE	AVERAGE NUMBER OF CLAMS PER SQUARE METER OF CLAM BED		
		May, 1929	August, 1929	January, 1930
	m.			
1	78.63	235	181	165
2	79.55	223	175	143
3	85.95	201	159	123
4	92.65	189	131	111
5	98.45	163	116	93
6	100.88	152	111	74
7	101.19	151	98	59
8	101.80	119	95	52
9	103.02	95	86	45
10	103.32	—	—	—
11	108.50	—	—	—
12	110.94	—	—	—
13	116.73	—	—	—
14	122.22	—	—	—
15	132.28	—	—	—

THE DETERIORATION OF PHILIPPINE SUGARS UNDER VARYING DEGREES OF HUMIDITY[1]

QUERINO D. RENDON

WITH TWO GRAPHS

The storage of sugar in the Philippine Islands has been a serious problem owing to excess production during the milling period and the remoteness of present markets. Recommendations were made by Browne (1918) and Deerr (1921) as to improvements in warehouse construction, methods of piling, storage, etc., but the loss caused by humidity which is not controlled has not been estimated. During the very long rainy season, the air in the islands is saturated with moisture; during the dry season, the reverse is true. When sugar is stored in warehouses near the seashore a constant humidity may exist.

The problem, therefore, to be considered is that of determining the maximum humidity which will not produce deterioration. Deterioration, or inversion, is caused by organisms and acidity. The growth of organisms such as yeasts, molds, and bacteria depends upon certain conditions of moisture, temperature, and nutrients.

The number of organisms present in any centrifugal sugar depends upon the cleanliness of machinery, storage tanks, and the water used for washing in the centrifugals. It is known that these organisms increase during storage, but the amount of increase and the deterioration accomplished have not been evaluated.

Acidity is dependent upon the hydrogen ion concentration of the original massecuite and the presence of acid-forming organisms. Therefore two factors enter into the deterioration of sugar; namely, inversion and destruction by organisms and inversion caused by acid formation.

REVIEW OF LITERATURE

Owen (1918) stated that moisture is one of the principal factors that cause the deterioration of sugar. If the percentage of moisture in a sugar divided by 100 minus the polarization is less than 0.333, the sugar will not deteriorate. He further stated that the other predisposing factor in sugar deterioration would naturally be supposed to be the degree of infection of sugar with microörganisms. The presence of small particles of cane fiber causes sugar deterioration because, according to Owen, "bagacillo" only influences sugar deterioration by the absorption and retention of moisture by means of which a moist zone is created in which deterioration can take place. The size of the grain of sugar is another factor; the smaller the grain of a sugar the greater will be the amount of film surface exposure.

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Kopeloff and Kopeloff (1920) found that molds play an important part in the deterioration of sugar in that they secrete invertase which causes the destruction of sucrose.

Deerr (1921) observed that the factors which influence the growth of all of these organisms are mainly temperature and the concentration of the film of molasses that forms their habitat. Favorable growth takes place from 35° to 40°C.; the deterioration is almost inhibited at 20°C., and becomes noticeable as the temperature rises. Microörganisms generally are unable to develop in very concentrated solutions owing to the phenomenon known as plasmolysis, and therefore a supersaturated film of molasses will act to some degree as a preventive of deterioration.

Browne (1918) also observed that temperature influences the growth of organisms. Warm weather is favorable for their development and the sugars suddenly begin to undergo a rapid decrease in polarization. The uneven distribution of moisture is the cause of the deterioration of the low moisture sugar; the average percentage of moisture is low, but there are zones of sugar in the bag in which the percentage of moisture is relatively high. This uneven distribution of moisture is produced more commonly by the migration of moisture after sugar is bagged, with the result that the liquid films become more concentrated on some grains of sucrose and more dilute upon others. Fermentation will then set in where the films are more dilute, the result being that the average mixed sample of the lot shows deterioration, although the average moisture content may appear to be well within the limit for good keeping. This migration accounts for the "sweating" of the raw sugar, the result of warm packing. It is very evident that when warm sugar is packed in a bag, there will be an expulsion of water from the center towards the cooler surface. Zones of higher moisture content are formed which, with the favoring of warmth from the interior of the bag, become exceedingly favorable for the development of microörganisms. Migration of moisture may take place not only within the bag but may proceed from one bag to another.

Owen (1911) concludes that the destruction of sucrose induced by the organisms is by means of an enzyme which has been termed *levanase*. This enzyme is extracellular in its action and breaks down sucrose as follows:

$$C_{12}H_{22}O_{11} = C_6H_{12}O_6 + \underbrace{C_6H_{10}O_5}_{\text{levan}}$$

The formation of levan in sugars introduces an error in the single polarization method of determination of sucrose. This error causes a decrease of .6V for every 1 per cent of gum. Owing to this factor of error, a sugar, in which gum formation has taken place, would show a decrease in sucrose.

The spores of the species of organisms causing deterioration of sugar are highly resistant to heat and survive different processes of manufacture, thus forming in part the contamination of the final products. They could exist or thrive well with poor nutrient. The gum formation of sucrose is favored by slightly alkaline reaction of the medium.

Spencer (1917) says that the size and hardness of the crystal, the cleanliness of the factory and process, the packing conditions, the moisture content of the sugar or the composition of the residual syrup on the crystal and the character of the warehouse itself, all influence the keeping qualities; it is also possible that washing the sugars in the centrifugals, without following this with thorough drying in the machines, has an adverse effect in storage on account of the dilution of the film of molasses on the crystals; Claassen, according to Spencer (1917), observed that when the film of molasses surrounding the crystals is supersaturated the microörganisms cannot develop, hence the sugar has a good keeping quality. Deterioration is generally believed by investigators to be usually due to bacteria and yeasts. Gain in polarization is not always an indication that a sugar has not suffered a loss of sucrose, such loss may be affected by a greater loss of water, thus giving the sugar a polarization higher than in the original test.

Kopeloff, Kopeloff, and Welcome (1921) found that the number of microörganisms together with moisture ratio (D. F.) are the determining factors in sugar deterioration. Mold spores contain enzymes capable of forming gum in sucrose solutions of all concentrations up to the saturation point. This gum formed is levan, having a specific rotation of 40°, a melting point of 200°C., and forming levulose on hydrolysis They have also found that the use of superheated steam in the centrifugal will reduce the number of microörganisms more than 90 per cent and consequently may eliminate deterioration if the moisture ratio, etc., are likewise properly controlled.

OBJECT OF THE PRESENT WORK

There were two objects in running this work: *a.* To determine the deterioration of cane sugar under varying degrees of humidity for different intervals of storage. *b.* To determine the number of organisms present and rate of growth under different conditions of humidity.

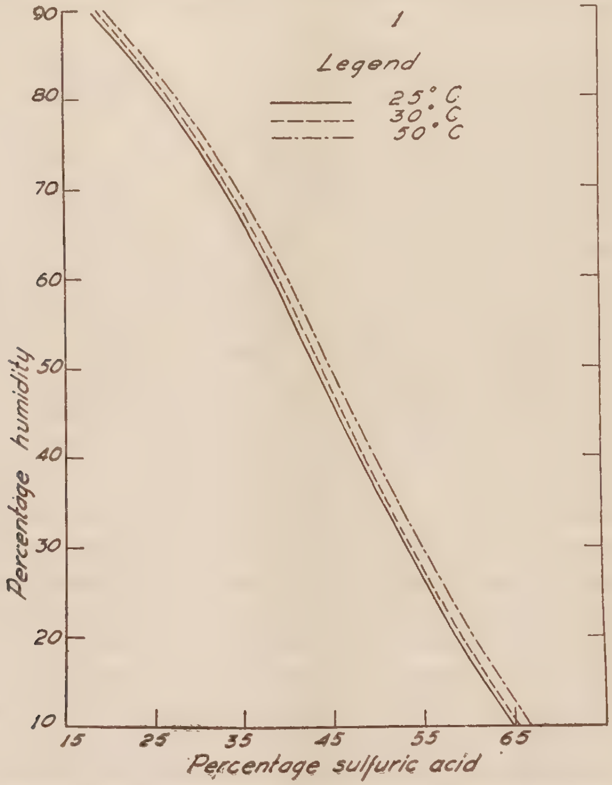
TIME AND PLACE OF THE PRESENT WORK

The work was performed in the U. P. Sugar Mill at the College of Agriculture at Los Baños, Laguna, from December 1, 1928, to May, 1929.

MATERIALS

Sugar. Eight different samples of sugar from different mills were used in this investigation. Six were brown and two were refined. A large amount was desired, but additional samples could not be obtained on account of non-coöperation of management.

Chemicals and apparatus. C.P. chemicals, glassware calibrated at 27 1/2°C. were used throughout. A Bausch and Lomb polariscope calibrated at 27 1/2°C. was used for sucrose determinations. The Department of Plant Pathology coöperated by evaluating the organisms per gram of commercial sugar.



Graph 1.—Showing the relationship between relative humidity and sulfuric acid solutions.

METHODS

For the control of humidity, dessicators were prepared according to Wilson (1921) which gave a humidity of the desired amount. These dessicators served as chambers giving a humidity of 50, 60, 70, 80, 90, and 100 per cent. Curve on graph number 1 gives proportion of H_2O and acid. Very large dessicators which could hold eight small sacks of the sugar were used. Small sacks of sugar were placed in these dessicators and were allowed to remain for a stated period of time.

For culture medium, different amounts of chemicals were used and prepared according to Kopeloff and Kopeloff (1919). Organisms were determined in a 1-100 dilution. Petri dish cultures were prepared and used with media according to the following formula:

H_2O	1000	cc.
Sucrose	50	grams
Peptone	5	grams
NH_4NO_3	1	gram
$K_2H\ PO_4$	1	gram
KCl	1.5	grams
$MgSO_4$	.25	gram
$FeSO_4$	.01	gram
Agar	20	grams

Colonies were counted after a 24-hour incubation period. The counting of organisms was done twice for every sample after 90 and 120 days.

Moisture, polarization, inversion, sucrose, apparent purity, gravity purity, and deterioration factor were determined according to *Methods of Chemical Control for Cane Sugar Factories* (1924). The analyses were made after 60, 90, and 120 days.

RESULTS OF THE DETERMINATION

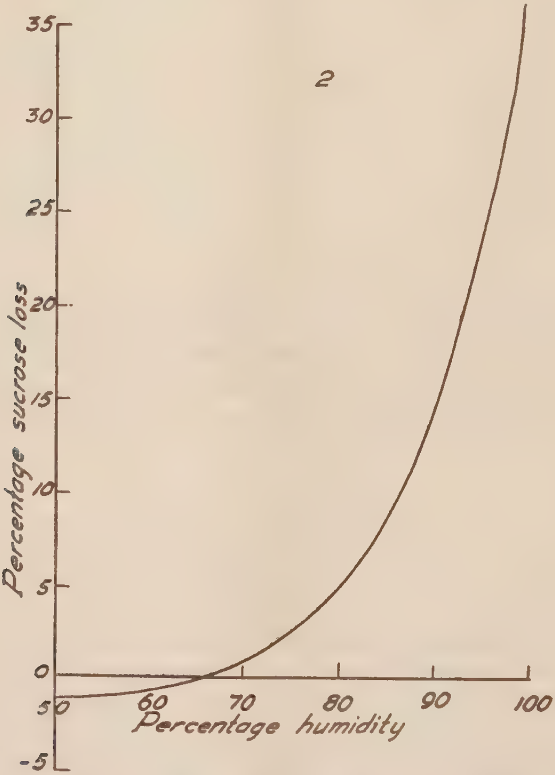
Tabulation of results

All the results of this work are presented in tabulated form. Table 1 presents both chemical and bacterial analyses after 60 days; table 2, after 90 days; table 3, after 120 days; table 4 shows the conditions of sugars after 60, 90, and 120 days; table 5 illustrates the behavior of increase or decrease of polarization against percentage of humidity after 120 days. The last results are illustrated on graph 2. Graph 1 gives the percentage humidity based upon percentage H_2SO_4 and temperature. The temperature used here is 30°C., this being the nearest to the ordinary room temperature.

DISCUSSION OF RESULTS

Chemical analysis

Table 1 shows the effect of humidity on sugar after 60 days under six different degrees of humidity. Under 50 per cent, it was observed that polarization increased with corresponding increase in sucrose. The condition of the samples is shown on table 4. All sacks on the 50 per cent were stiff when first examined. It was first thought that the sugars had absorbed some moisture which was supposed to be responsible for the hardening or caking; but, after chemical analysis, it was found that every sample taken gave an increase in polarization and likewise an increase in percentage of sucrose. This increase was detected until the 60 per cent humidity. There were some sugars that increased or decreased on the 70 per cent humidity and, beyond this, the decrease was apparent. This increase does not mean that sucrose has increased; it is due to the loss of moisture, which loss has been compensated for by some more sucrose taken to make a normal weight of 26 grams during sampling. Comparing with the control, the increase varies from 0.1 to 1.8 per cent on the 50 per cent, 0.1 to 0.8 on the 60 per cent, and an average decrease of 0.75 per cent on the 70 per cent. It is on this last humidity that sugars begin to show signs of deterioration where the ratio of moisture to 100 minus polarization is beyond the factor of safety which is .333 (Owen, 1918). With increase of polarization, there is a corresponding increase also of both apparent and gravity purity. The same phenomenon happened after the periods of 90 and 120 days.



Graph 2.—Showing increase and decrease in sucrose in commercial sugar under different degrees of relative humidity.

During the three stated periods, sugar suffered much deterioration beginning at 70 containing to 100 per cent humidity. As shown in the tables the variations on the decreases or increases are not uniform. These irregular variations can be explained by the fact that the more exposed samples absorbed greater amounts of moisture than the less exposed ones though subjected to the same controlled humidity. The sacks were arranged in piles of two in each dessicator in the same manner as bags of sugar are piled in the storage warehouses. Those that are in the middle have little space exposure, hence less amount of moisture is taken than those that are at the top and bottom. That the arrangement of the sacks in the dessicator is not the same as that in any of the other dessicators, accounts also for the other cause of these variations. Sample D in table 2 illustrates this fact. At 70 per cent its polarization is 97.7; while in 80 per cent, it has decreased to 97.5 which is even .4 higher than the control. This particular sample had the finest grains among all the sugar samples examined. Like the two refined sugars F and G, it had suffered the worst deterioration, having taken in a large amount of moisture, especially on the 90 and 100 per cent humidity after 120 days. According to Spencer (1917), the finer the grains, the greater the surface area exposed to moisture, hence a large amount of moisture is absorbed. This moisture dilutes the film of molasses that adheres to the crystals, and, according to Browne (1918), the more dilute the film is, the better it stimulates the favorable growth of organisms, one of the factors responsible for the deterioration of sugars. This conclusion is corroborated by Kopeloff and Kopeloff (1919).

Once the sugar has undergone deterioration, the factor of safety becomes proportionately less as the polarization and moisture decrease and increase because the organisms are taking part.

As a result of the observation it was found that the 50 and 60 per cent humidity absorbed moisture. The power of absorption was not uniform in every sack, it depends on the surface area exposed. Under the same condition the power of absorption of H_2O by the samples from the 70, 80, 90, and 100 per cent humidity was not uniform. According to Browne (1918), the uneven distribution of moisture is produced more commonly by the migration of moisture not only within the bag but from one bag to another. This is the reason there is higher polarization of A on the 90 per cent humidity after 120 days than that of the same sample on the same humidity after 60 or 90 days. It should be stated here that sample A suffered severe deterioration because the condition of the crystals on reaching the college was partially moist; it was the only sample sent in a bag; the others were placed in tightly covered glass bottles. This migration of moisture takes place in two ways; namely, by diffusion or capillarity and by evaporation; the latter is only possible when the vapor pressure surrounding the bags is less than that of the sugar in the bags, or when the percentage of humidity is almost 60 to 70 per cent.

Owing to the limited amount of samples, there were some sugars that were not determined under 90 and 100 per cent humidity after 120 days; but there were enough for organisms determination.

The decrease in polarization after 120 days ranged from .3 to 36 per cent and is shown on graph 2. This decrease is inversely proportional to the increase in moisture and percentage of humidity.

Bacterial count

After 60 days, the bacterial count was not performed as necessary apparatus was not available. Table 2 shows the behavior of organisms on different degrees of humidity. It was found that the period of incubation is 24 hours, the work being done in the hot season of the year during which a maximum temperature of 36° C. was registered at the College. It is interesting to note that the larger the amount of moisture, the greater the number of organisms and the lower the polarization or sucrose becomes. This shows that deterioration in sugar occurs when organisms are present. According to Owen (1918), the predisposing factor in sugar deterioration would naturally be supposed to be the degree of infection of sugar with organisms; Kopeloff, Kopeloff, and Welcome (1921) corroborated this statement.

It is shown on both tables 2 and 3 that the increase in moisture is accompanied by the increase in number of organisms, and the corresponding decrease in polarization or sucrose. This increase in organisms was so marked that the determination on both 90 and 100 per cent humidity after 90 and 120 days was only possible with the dilution factor of 2,000; still the colonies were so numerous that counting was done on three samples only. As illustrated in the tables, deterioration is serious with increase of moisture which stimulates the increase of organisms.

SUMMARY

1. Moisture is one of the principal factors that cause the deterioration of sugar.
2. The increase of moisture in sugar favors the rapid growth of organisms.
3. Organisms are the other factors of deterioration. They grow rapidly with increase of moisture and temperature and introduce an error in polarization method of determination of sucrose.
4. The minimum degree of humidity in which sugar will not deteriorate is 66.2 per cent.
5. Average deterioration for the eight sugars indicate a possible loss of 36 per cent at 100 per cent humidity in 4 months.

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TABLE 1

Analyses after 60 days

SAMPLE	CONTROL							50 PER CENT HUMIDITY					
	Moi.	Pol.	App.	Suc.	Gra.	Det.	Nu.	Moi.	Pol.	App.	Suc.	Gra.	Det.
	per cent			*per cent*				*per cent*			*epr cent*		
A	.87	95.1	95.93	95.8	96.64	.178	4,100	.17	96.9	97.07	97.0	97.17	.055
B	.89	97.6	98.48	98.1	98.98	.371	4,900	.16	98.5	98.66	98.7	98.86	.107
C	.85	98.1	98.96	98.8	99.67	.447	3,500	.16	98.3	98.46	98.9	99.06	.094
D	.92	97.1	98.00	97.4	98.30	.317	4,560	.32	97.6	97.91	98.3	98.62	.133
E	.94	96.7	97.62	97.1	98.02	.285	5,100	.38	96.8	97.14	97.2	97.54	.109
F	.39	98.7	99.06	98.9	99.26	.300	1,960	.14	99.1	99.24	99.5	99.64	.156
G	.36	98.8	99.19	98.7	99.09	.300	1,250	.13	99.2	99.33	99.6	99.73	.163
H	.87	97.3	98.15	98.2	99.06	.322	3,860	.18	97.5	97.68	98.8	98.98	.072

SAMPLE	60 PER CENT HUMIDITY						70 PER CENT HUMIDITY					
	Moi.	Pol.	App.	Suc.	Gra.	Det.	Moi.	Pol.	App.	Suc.	Gra.	Det.
	per cent			*per cent*			*per cent*			*per cent*		
A	.24	96.3	96.53	96.8	97.03	.065	2.24	93.3	95.44	94.2	96.36	.335
B	.20	98.4	98.60	98.7	98.90	.125	.80	97.6	98.39	98.6	99.40	.333
C	.34	98.2	98.54	98.5	98.84	.189	.85	97.5	98.34	98.3	99.14	.340
D	.39	97.2	97.58	97.5	97.88	.139	.88	97.8	98.67	98.3	99.17	.400
E	.38	96.1	96.47	97.2	97.57	.097	.81	97.7	98.50	98.9	99.79	.352
F	.19	99.0	99.19	99.3	99.49	.190	.41	98.4	98.81	99.2	99.61	.256
G	.15	99.2	99.35	99.5	99.65	.188	2.71	91.9	94.46	93.4	96.00	.334
H	.22	97.5	97.71	98.7	98.92	.088	.83	97.2	98.01	98.4	99.22	.296

SAMPLE	80 PER CENT HUMIDITY						90 PER CENT HUMIDITY					
	Moi.	Pol.	App.	Suc.	Gra.	Det.	Moi.	Pol.	App.	Suc.	Gra.	Det.
	per cent			*per cent*			*per cent*			*per cent*		
A	3.55	87.2	88.66	89.1	90.60	.129	4.71	85.9	87.36	87.2	88.68	.118
B	.94	96.7	97.62	97.9	98.83	.285	2.01	93.2	94.16	94.1	95.06	.149
C	1.02	96.7	97.70	97.6	98.61	.309	.98	95.8	96.75	96.5	97.46	.233
D	.89	97.8	98.68	98.5	99.38	.405	1.03	94.8	95.79	95.0	95.99	.198
E	.91	96.3	97.18	97.5	98.40	.246	2.08	92.6	93.61	93.5	94.52	.146
F	.41	98.4	98.81	98.7	99.11	.256	.42	98.7	99.12	99.0	99.42	.323
G	.38	98.7	99.08	98.9	99.28	.292	1.03	96.3	97.30	97.0	98.01	.278
H	1.09	96.1	97.16	97.2	98.27	.279	1.22	94.6	95.77	95.7	96.88	.226

SAMPLE	100 PER CENT HUMIDITY					
	Moi.	Pol.	App.	Suc.	Gra.	Det.
	per cent			*per cent*		
A	7.24	80.0	86.24	81.0	87.32	.362
B	5.66	84.0	86.24	85.2	87.47	.358
C	1.24	96.5	97.71	97.2	98.42	.354
D	6.75	81.0	86.86	82.1	88.04	.355
E	2.72	91.9	94.47	93.2	95.81	.336
F	9.82	73.6	81.52	77.1	85.40	.372
G	4.67	84.0	85.95	86.3	88.30	.142
H	1.35	95.5	96.81	96.6	97.92	.300

TABLE 2

Analyses after 90 days

SAMPLE	50 PER CENT HUMIDITY								60 PER CENT HUMIDITY							
	Moi.	Pol.	App.	Suc.	Gra.	Det.	No. Org. Per Gr.	No. Mol. Per Gr.	Moi.	Pol.	App.	Suc.	Gra.	Det.	No. Org. Per Gr.	No. Mol. Per Gr.
	per cent			*per cent*					*per cent*			*per cent*				
A	.17	97.2	97.37	98.7	98.87	.061	1,900	None	.20	96.3	95.50	97.4	97.60	.054	4,050	None
B	.15	98.2	98.35	99.3	99.45	.083	1,600	None	.19	98.2	98.39	98.9	99.09	.106	4,000	None
C	.14	98.1	98.24	99.4	99.54	.074	1,400	None	.34	98.1	98.43	98.6	98.94	.179	3,450	None
D	.30	98.0	98.29	99.1	99.40	.150	2,600	None	.37	98.0	98.36	98.5	98.87	.185	4,500	None
E	.33	97.6	97.92	98.9	99.23	.138	3,800	None	.38	96.1	96.47	97.1	97.47	.027	4,900	None
F	.12	99.5	99.62	99.8	99.92	.240	950	None	.19	99.0	99.19	99.5	99.69	.190	1,650	None
G	.12	99.5	99.62	99.7	99.82	.240	850	None	.17	99.2	99.37	99.7	99.87	.212	1,200	None
H	.16	97.6	97.76	98.9	99.06	.067	1,250	None	.21	97.5	97.71	98.2	98.41	.084	3,250	None

SAMPLE	70 PER CENT HUMIDITY								80 PER CENT HUMIDITY							
	Moi.	Pol.	App.	Suc.	Gra.	Det.	No. Org. Per Gr.	No. Mol. Per Gr.	Moi.	Pol.	App.	Suc.	Gra.	Det.	No. Org. Per Gr.	No. Mol. Per Gr.
	per cent			*per cent*					*per cent*			*per cent*				
A	1.60	93.2	94.72	94.6	96.14	.235	60800	100	3.98	85.3	87.23	87.1	88.86	.135	62600	400
B	.82	97.5	98.31	98.9	99.72	.328	4850	100	1.02	96.3	97.29	96.8	97.80	.275	50700	200
C	.82	97.3	98.10	98.4	99.21	.304	3100	None	1.05	96.4	97.42	96.6	97.63	.292	47900	200
D	.83	97.7	98.52	98.7	99.53	.361	4150	200	.92	97.5	98.41	97.9	98.81	.368	71600	200
E	.81	97.7	98.50	98.8	99.61	.352	4950	200	.94	96.0	96.91	96.0	96.91	.235	71200	300
F	.35	98.2	98.54	99.3	99.65	.194	1150	None	.36	98.2	98.55	99.1	99.46	.200	1100	100
G	1.70	83.2	84.64	86.6	88.10	.101	44400	400	.44	98.7	99.14	99.4	99.84	.338	1400	100
H	.83	97.2	98.01	98.6	99.43	.307	3750	100	1.08	95.8	96.85	96.4	97.45	.257	59600	300

SAMPLE	90 PER CENT HUMIDITY								100 PER CENT HUMIDITY							
	Moi.	Pol.	App.	Suc.	Gra.	Det.	No. Org. Per Gr.	No. Mol. Per Gr.	Moi.	Pol.	App.	Suc.	Gra.	Det.	No. Org. Per Gr.	No. Mol. Per Gr.
	per cent			*per cent*					*per cent*			*per cent*				
A	4.02	85.1	88.66	86.4	90.02	.270	268000	700	5.45	76.0	80.38	77.4	81.86	.227	320000	1,300
B	1.45	93.1	94.47	93.4	94.77	.210	Plenty	700	5.04	79.0	83.19	79.9	84.14	.240	Plenty	1,200
C	1.27	95.6	96.83	95.6	96.83	.289	Plenty	500	1.01	95.6	96.58	95.8	96.78	.230	Plenty	1,200
D	1.06	93.9	94.91	94.2	95.21	.174	232000	600	4.07	81.0	84.44	82.0	85.48	.214	Plenty	1,900
E	2.54	92.1	94.50	92.6	96.01	.322	216000	800	2.20	91.0	93.05	91.1	93.15	.244	Plenty	1,900
F	.88	98.2	99.07	99.1	99.98	.489	Plenty	200	5.62	72.7	77.03	75.6	80.10	.206	296000	2,200
G	1.03	96.2	97.24	97.3	98.34	.279	Plenty	600	5.01	82.6	86.96	84.2	88.64	.288	236000	1,800
H	1.05	94.2	95.20	94.8	95.81	.181	Plenty	700	1.03	95.3	96.29	95.3	96.29	.219	Plenty	1,100

TABLE 3

Analyses after 120 days

SAMPLE	60 PER CENT HUMIDITY								50 PER CENT HUMIDITY							
	Moi.	Pol.	App.	Suc.	Gra.	Det.	No. Org. Per Gr.	No. Mol. Per Gr.	Moi.	Pol.	App.	Suc.	Gra.	Det.	No. Org. Per Gr.	No. Mol. Per Gr.
	per cent			*per cent*					*per cent*			*per cent*				
A	.24	97.3	97.53	98.5	98.74	.089	1000	None	.21	96.1	96.30	97.3	97.50	.054	4150	250
B	.17	98.2	98.37	99.0	99.17	.094	950	None	.19	98.1	98.29	98.6	98.79	.100	4100	None
C	.17	98.4	98.57	99.1	99.27	.106	350	None	.33	98.0	98.32	28.7	99.03	.183	3250	None
D	.16	98.2	98.31	98.4	98.56	.089	800	None	.37	98.2	98.56	98.8	99.17	.206	4550	100
E	.32	97.6	97.91	98.0	98.31	.133	650	None	.38	98.2	98.57	98.8	99.18	.211	4900	200
F	.11	99.5	99.61	99.7	99.81	.220	200	None	.18	99.1	99.28	99.2	99.38	.200	1700	None
G	.08	99.6	99.68	99.7	99.78	.200	150	None	.17	99.3	99.47	99.4	99.57	.243	1250	None
H	.14	97.7	97.84	98.1	98.24	.061	600	None	.20	98.2	98.40	98.8	99.00	.111	3350	150

SAMPLE	70 PER CENT HUMIDITY								80 PER CENT HUMIDITY							
	Moi.	Pol.	App.	Suc.	Gra.	Det.	No. Org. Per Gr	No. Mol, Per Gr.	Moi.	Pol.	App.	Suc.	Gra.	Det.	No. Org. Per Gr	No. Mol. Per Gr.
	per cent			*per cent*					*per cent*			*per cent*				
A	1.61	93.2	94.73	94.8	96.35	.273	60850	200	3.97	86.3	88.03	88.2	89.97	.144	64400	400
B	.81	98.3	99.10	98.5	99.30	.477	4850	100	1.08	94.8	95.84	95.9	96.95	.908	50750	300
C	.96	95.8	96.73	95.3	97.23	.229	3200	100	1.04	95.4	96.40	95.8	96.81	.226	47850	300
D	.82	98.3	99.11	98.7	99.52	.482	4160	100	.96	90.5	91.38	90.8	91.68	.101	71350	300
E	.81	97.6	98.40	97.8	98.60	.338	4950	100	.95	92.5	93.39	92.9	93.79	.127	71250	400
F	.38	99.3	99.68	99.5	99.88	.543	1250	None	.32	99.3	99.62	99.6	99.92	.457	1650	200
G	1.71	82.9	84.34	85.0	86.48	.100	44600	250	.42	99.0	99.42	99.4	99.82	.420	1750	200
H	.83	96.2	97.00	97.1	97.91	.218	3800	100	1.35	91.4	92.65	93.4	94.68	.151	59650	600

SAMPLE	90 PER CENT HUMIDITY								100 PER CENT HUMIDITY							
	Moi.	Pol.	App.	Suc.	Gra.	Det.	No. Org. Per Gr.	No. Mol. Per Gr.	Moi.	Pol.	App.	Suc.	Gra.	Det.	No. Org. Per Gr.	No. Mol. Per Gr.
	per cent			*per cent*					*per cent*			*per cent*				
A	5.17	90.9	93.88	91.7	94.70	.348	Plenty	800	5.61	—	—	—	—	—	680900	2600
B	4.01	89.6	93.34	90.1	93.86	.386	320000	900	5.01	78.3	84.43	79.5	83.69	.231	Plenty	2100
C	2.18	—	—	—	—	—	Plenty	700	3.09	—	—	—	—	—	Plenty	2100
D	2.24	—	—	—	—	—	Plenty	1100	4.07	73.1	76.20	74.2	77.35	.151	Plenty	2200
E	1.08	93.4	94.42	93.0	94.02	.164	Plenty	900	5.18	68.6	72.35	69.2	72.98	.165	Plenty	2700
F	4.04	84.2	87.74	86.0	89.62	.256	360600	1000	6.01	64.2	68.31	65.1	69.26	.168	621000	2400
G	5.06	75.8	82.68	79.6	83.84	.209	400000	900	5.81	71.8	76.23	72.0	76.44	.206	432150	2300
H	4.33	82.3	86.02	83.8	87.59	.245	Plenty	900	1.02	94.6	95.57	95.9	96.89	.189	Plenty	1400

TABLE 4

Condition of the sugars after 60, 90, and 120 days

SAMPLE	50 PER CENT HUMIDITY			60 PER CENT HUMIDITY			70 PER CENT HUMIDITY		
	After 60 days	After 90 days	After 120 days	After 60 days	After 90 days	After 120 days	After 60 days	After 90 days	After 120 days
A	Caked	Caked	Dry	Partially caked	Partially caked	Normal	Partially moist	Partially moist	Partially moist
B	"	"	"	"	"	"	"	"	Normal
C	"	"	"	"	"	"	"	"	Partially moist
D	"	"	"	"	"	"	"	"	"
E	"	"	"	"	"	"	"	"	Normal
F	"	"	"	"	"	"	"	"	"
G	"	"	"	"	"	"	Very moist	Very moist	Wet
H	"	"	"	"	"	"	Partially moist	Partially moist	Normal

SAMPLE	80 PER CENT HUMIDITY			90 PER CENT HUMIDITY			100 PER CENT HUMIDITY		
	After 60 days	After 90 days	After 120 days	After 60 days	After 90 days	After 120 days	After 60 days	After 90 days	After 120 days
A	Partially wet	Wet	Moist	Wet	Wet	Wet	Wet	Wet	Wet
B	Moist	Partially wet	Moist	"	Partially wet	"	"	"	"
C	"	"	"	Very moist	"	"	"	"	"
D	Normal	Normal	"	"	"	"	"	"	"
E	Partially moist	Moist	"	"	"	"	"	"	"
F	"	"	Normal	"	Moist	"	"	"	"
G	"	"	"	"	"	"	"	"	"
H	"	"	Moist	"	"	"	"	"	"

TABLE 5

Percentage increase or decrease in polarization after 120 days

SAMPLE	CONTROL	50 PER CENT HUMIDITY			60 PER CENT HUMIDITY			70 PER CENT HUMIDITY			80 PER CENT HUMIDITY			90 PER CENT HUMIDITY			100 PER CENT HUMIDITY		
	Polarization	Polarization	Difference	Difference	Polarization	Difference	Difference	Polarization	Difference	Difference	Polarization	Difference	Difference	Polarization	Difference	Difference	Polarization	Difference	Difference
				per cent			*per cent*			*per cent*			*per cent*			*per cent*			*per cent*
A	95.1	97.3	2.2	2.31	96.1	1.0	1.05	93.2	-1.9	2.04	86.3	-8.8	-10.20	90.9	- 4.2	- 4.62	——	——	——
B	97.6	98.2	0.6	0.61	98.1	0.5	0.51	98.3	0.7	0.72	94.8	-2.8	- 2.95	89.6	- 8.0	- 8.93	78.3	-19.3	-24.65
C	98.1	98.4	0.3	0.31	98.0	-0.1	-0.10	95.8	-2.3	-2.40	95.4	-2.7	- 2.83	——	——	——	——	——	——
D	97.1	98.2	1.1	1.13	98.2	1.1	1.13	98.3	1.2	1.24	90.5	-6.6	- 7.29	——	——	——	73.1	-24.0	-32.83
E	96.7	97.6	0.9	0.93	98.2	1.5	1.55	97.6	0.9	0.93	92.5	4.2	- 4.54	93.4	- 3.3	- 3.53	68.6	-28.1	-40.96
F	98.7	99.5	0.8	0.81	99.1	0.4	0.41	99.3	0.6	0.61	99.3	0.6	0.61	84.2	-14.5	-17.22	64.2	-34.5	-53.74
G	98.8	99.6	0.8	0.81	99.3	0.5	0.51	82.9	-5.9	-7.12	99.0	0.2	0.20	75.8	-23.0	-30.34	71.8	-27.0	-37.60
H	97.3	97.7	0.4	0.41	98.2	0.9	0.93	96.2	-1.1	-1.14	91.4	-5.9	- 6.46	82.3	-15.0	-18.23	94.6	- 2.7	-28.54
Average	——	——	——	0.92	——	——	+0.75	——	——	-1 15	——	——	- 4.18	——	——	-13.81	——	——	-36.39

A STUDY ON THE PREPARATION OF RATIONS AS RELATED TO THE GROWTH AND DEVELOPMENT OF PIGS[1]

JUANITO T. GARRIDO

WITH ONE CHART

INTRODUCTION

A preliminary local study on this subject by Bolivar in 1928 indicated that the way hog rations are prepared has specific effects on the growth and development of pigs. Lack of facilities, unfortunately, prevented him at the time his study was made from placing under test all the six different methods by which he prepared a ration most commonly used in the College. In the present work an attempt was made to add to the knowledge on this subject. In particular, effort was directed in making a direct comparison of the six different preparations Bolivar placed under trial. These preparations were first tested under conditions similar to those of his work. Then they were put to test on pigs at different ages under different sets of conditions.

Review of past work on the subject

In addition to the literature cited by Bolivar (1928) in his thesis, the following may be mentioned:

Henry (1899) compared whole corn with corn meal for fattening swine. He found that the pigs fed whole corn and middlings, consumed 4.97 kgm. ration for one kgm. gain; those fed corn meal and middlings consumed 5.07 kgm. per kgm. gain live weight.

Hills (1894) reports that pigs fed on cooked ration consumed 1.64 kgm. of corn meal mixture for one kgm. gain, while those fed on uncooked ration consumed only 1.57 kgm. of corn meal mixture for the same gain.

Snyder (1894), in connection with his digestion experiment on potatoes as feed for pigs, states that a large quantity of albumin may be lost in cooking. He found that 80 per cent of the albumin was extracted if peeled potatoes were put in cold water to cook, but only 10 per cent if put in hot water.

Bolivar (1928) of this College in the results of his experiments on weanling pigs on dry lot and on limited grass pasture systems of feeding states that, of the methods of preparations tried, soaked ration with the corn ground gave the best results; unsoaked ration, second; and cooked ration the poorest.

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[1] Thesis presented for graduation, 1929, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 320; Experiment Station contribution No. 681 Prepared in the Department of Animal Husbandry under the direction of Dr. Mariano Mondoñedo.

Objects of the experiment

This work was conducted: (*a*) to make a direct comparison of the six preparations of the ration mixture used by Bolivar in 1928; (*b*) to determine the effect of the preparations on the pigs at different ages under grain—camote pasture system of feeding; (*c*) to determine the effect upon the pigs of the same preparations during a long period of feeding.

Time and place

The work was conducted at the College of Agriculture, Los Baños. It was divided into three periods. The first period lasted from April 3 to June 16, 1928; the second, from June 16 to August 25, 1928; the third, from August 25 to November 3, 1928. The first period covered a period of 73 days; the second and third, each covered a period of 70 days. The whole work covered a period of 213 days.

MATERIALS AND METHODS

Materials

Weanling pigs. Thirty-six high grade Berkjala weanling pigs, raised in the College, were used. They were fairly uniform in type, quality, and condition. They were divided particularly as to weight, sex, and condition into six uniform lots of six pigs each. There were seventeen females and nineteen males.

Feeds used. For all the lots, the same proportion of corn, rice bran, copra meal, and dried shrimps for concentrates; ground corn-cob charcoal, common salt, copperas, Glauber's salts (Na_2SO_4), and calcium phosphate ($Ca_3(PO_4)_2$) for mineral mixture were used.

The ration. The proportion of the feeds used in the ration of each of the different lots was:

20	parts corn
60	parts rice bran
15	parts copra meal
5	parts dried shrimps

One per cent of the following mixture of minerals was added to the ration of each lot:

Common salt	45 parts
Ground corn-cob charcoal	40 parts
Copperas	5 parts
Glauber's salts (Na_2SO_4)	5 parts
Calcium phosphate ($Ca_3(PO_4)_2$)	5 parts
Total	100 parts

Methods

The experiment was divided into three periods. The first period was to determine the effect on weanling pigs of feeding for 73 days the same mixed ration but differently prepared. The second and third periods of 70 days each were a continuation of the first period. The last parts of experiment were conducted to determine what effect or effects each of these preparations had on the same pig as it grew older. There were six lots with six pigs in each to correspond to the six different preparations of rations under test.

Lot I was given a ration with shelled whole corn, cooked.

Lot II was given the same ration as lot I, except that it was soaked instead of cooked.

Lot III was given the same ration as lot I, except that water was added to the ration immediately before feeding.

Lot IV was given a ration with the corn ground, cooked.

Lot V was given the same ration as lot IV, except that it was soaked instead of cooked.

Lot VI was given the same ration as lot IV, except that water was added to the ration immediately before feeding.

Preparation of rations: Cooking the ration. The ration for the whole day was cooked in the morning. It was usually boiled for about 45 minutes. It was considered cooked when it became pasty in consistency. It was fed cold.

> *Soaking.* The rations were soaked for about 10 to 14 hours before they were fed. For the 7:00 to 8:00 a. m. feeding the ration was put to soak at 5:00 o'clock the afternoon before, and for the 5:00 to 6:00 p. m. feeding it was put to soak at 7:00 in the morning.
>
> *Unsoaked ration.* Water was added to the ration immediately before feeding.

Feeding. In this experiment, the pigs were hand fed twice a day at regular hours between 7:00 and 8:00 a. m. and 5:00 and 6:00 p. m. The amount fed was determined by what each lot would clean up readily without waste.

Weighing. Throughout the course of the experiment, individual weekly weights were taken. The weighing was done from 3:00 to 4:00 p. m. before the pigs received their evening meal. The pigs were bathed one hour before each weighing so there would be no mud on them. For the initial and final weights, the average of the weights of each pig for three consecutive days at the beginning and closing of each period was taken.

Care and management. Throughout the experiment the pigs were given the same treatment, preparation of rations excepted. They were allowed to run together in a common camote pasture between meals, at night, and in the daytime. Whenever the camote pasture was about finished and before a fresh one was available, 4 kgm. of camote vines were given to the lot of pigs every noon and evening. On hot days, the pigs were allowed to go into the hog house and were given water. In the cooler part of the afternoon or sometimes after their evening meal, they were driven back to the pasture.

There were five camote pastures, one-fourth of a hectare each, available for use in the experiment. These were used in rotation, Usually the pigs could exhaust the vines within 20 days, but they enjoyed digging up the roots of camote or grazed on the wild grass after the camote was gone. The pigs were usually kept for one month in the same pasture. Shortage of camote pasture was replaced at times by supplying camote soilage. The pigs on pasture had no shelter other than the shade of the trees growing along the fences.

At feeding time the pigs were driven from the pasture to the hog house. With the pens open, the pigs by lots soon learned to go to their own pens.

Observations

First period. (1). On May 10, pig 635 in lot II was found to be infested with ascaris. It was given a 25 cc. dose of the following prescription:

Oil of chenopodium	20 cc.
Tartar emetic	5 grams
Oil of turpentine	75 cc.
Castor oil	225 cc.

It was found to be heavily infested, as shown by the ascaris expelled. Two weeks later, to prevent further contamination of the other pigs this pig was removed from the herd and was replaced by pig 695.

Second period. (1). From August 12 to 17, most of the pigs were not making as good gains as they had been previously; the exceptions were: pigs 653 in lot I, 693 and 695 in lot II, all in lot III, 647 and 650 in lot IV, and all in lot VI. In these five days the pastures were exhausted and the pigs dug up camote roots.

(2). As pig 683 in lot IV was found to be heavily infested with round worms it was taken from the experiment on June 16 and pig 711 from the College herd was put in instead. As it was found to be heavily infested with another intestinal parasite (*Trichuris suis*), pig 711 was dropped on August 12. Upon discovery of the infestation the pig was immediately isolated from the rest of the herd to prevent infestation of other pigs and to undergo treatment.

Third period. From October 2 to 17, the pigs did not gain as much as in the previous period because the camote pasture was practically exhausted. This condition was remedied later when an adjacent pasture was opened.

(1). Pigs in lot I (cooked whole corn) at the end of the period had made the slowest rate in growth. They ate much but they looked thinner than the pigs in the other lots. They were listless, restless, and seemed discontented. They seemed to be always hungry, going from trough to trough and making a great noise in their pen before feeding time. After eating they would lie down and were not inclined to move.

(2). Pigs in lot II (whole corn, soaked) were a little better than those in lot I. They appeared more mature than the pigs of the other lots. They always had a good appetite.

(3). Pigs in lot III (unsoaked whole corn) were considered to be the best of all. They had well developed bodies. As their growth had been uniform, they were about the same size. They were active and vigorous, always grazing when in the pasture. Sometimes they passed in their feces undigested corn, especially during the greater part of the last period. They were easily approached.

(4). Except pigs 643 and 654 the pigs in lot IV (cooked ground corn) were paunchy and sway-backed. Their skin was dry and rough and covered with peeling scurf. Their eyes were dull. They were lazy, seeming to prefer to lie down in a corner rather than to go around and hunt for something to eat as the pigs in other lots did. They did not, however, show loss of appetite; they ate their feed well.

(5). Pigs in lot V (soaked ground corn) were all healthy. They approached the bacon type. They were rangy. Their bodies were long, narrow, and compact. Their eyes were bright. They were quiet and easily approached. This lot was considered inferior to lot III because the growth of the pigs was not uniform. Except during the first 18 days of the period, they did not show any loss of appetite.

(6). Pigs in lot VI (unsoaked ground corn) were considered as good as lot III. At times the pigs in lot VI made greater gains than those in lot III, but they consumed more concentrates per 100 kgm. gain, so that lot VI was considered inferior to lot III in so far as economy of gain is concerned. The pigs were all fat, except pig 694 which was slightly less growthy than the others.

DISCUSSION OF RESULTS

First period

Contrary to the general belief that the greater the effort in preparation of rations, such as grinding, soaking, cooking, etc., the more rapid and economical the gains, results in this test showed that rations with little preparation gave the best gains. Lots III and VI (both unsoaked rations) gave the best results from the standpoint of the amount, rate, and economy of gains made. Between lot V (ground corn, soaked) and lot II (whole corn, soaked), there seemed to be a marked difference in the amount, rate, and economy of gains made, in favor of lot V. There was no appreciable difference between lot I (whole corn, cooked) and lot IV (ground corn, cooked).

The question that may naturally arise is: Why is it that better results were obtained from rations fed unsoaked than from the same ration mixture given after being soaked for hours in water or being cooked? In answering the question it must be borne in mind that the pigs were small (weanlings) and that they were under the grain-pasture system of feeding. Under these conditions it seems that soaking is not only unnecessary but retards growth and renders the gain more expensive. What is likely to take place in soaking is to increase unduly the bulk of the grain ration without increasing its content of nutriment. The capacity of young pigs to ingest feed is small and as these pigs were on pasture the greater part of the time the amount of dry matter that could be ingested by the ones on soaked rations was actually less than if it had been unsoaked. The difference of 3.95 kgm. between the amount of gains made per pig in lots III and VI (on unsoaked rations) and lots V and II (on soaked rations) seems small and insignificant, but actually, considering that the gains were made by the small pigs, this difference of 26 per cent in efficiency in favor of unsoaked rations is considerable. The results at once become more significant when it is noted that both lots III and VI on unsoaked rations gave the best results of the six lots under test; lot V (ground corn, soaked) was third; and lot II (whole corn, soaked) was the poorest.

With lot V (ground corn, soaked), lot I (whole corn, cooked), and lot IV (ground corn, cooked), there was practically no difference in the results obtained. (See chart 1.) No one of the three lots gave as good results as lots III and VI (unsoaked rations).

Lot II (whole corn, soaked) gave the poorest results. This was largely due to pig 635 which remained unthrifty throughout the feeding period. It was discovered later that it was infested with round worms. It remained unthrifty even after being treated with vermifuge. Even if this pig were excluded from the experiment because of sickness, the rate of growth of the other five pigs in the lot, though apparently healthy and making steady gains, was not sufficiently fast to keep the lot from occupying the last place. Whether the preparation (whole corn, soaked) made the ration physiologically unsuited and thus predisposed the pigs to the effect of other adverse conditions, as susceptibility to parasitic infestation, or the pigs failed to gain as much as the other lots because they happened to be affected by adverse conditions, is hard to determine. The fact remains that all the pigs were together, except at feeding time, and that all were exposed to the same parasitic infestation.. However, it seems to be the consensus of opinion that pigs that are unhealthy from any cause need to have their rations prepared to facilitate digestion and assimilation. In lot II the pigs could not make as much use of the whole corn as those in the other lots where the corn was ground or cooked. True, the ration was soaked so as to facilitate digestion, but it appears that this good effect was not sufficient to offset the adverse effect of soaking, that is, making the grain ration more bulky thereby reducing the amount of dry matter that the pig should eat to maintain its normal growth.

Results in this period of feeding showed that there was little or no advantage obtained from grinding corn for healthy weanling pigs under grain-pasture system of feeding. Under this condition the pigs seemed to enjoy crunching their own corn. Doing this crunching probably facilitated the secretion of digestive juices which promoted digestion, assimilation, and, consequently, more economical gains.

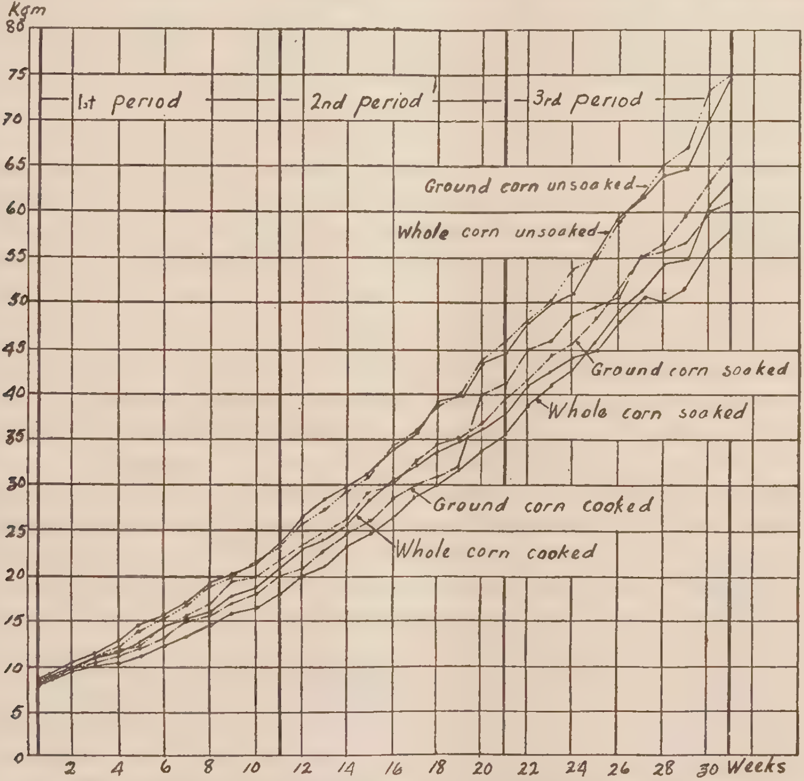

Chart 1.—Showing results in the three periods of the different rations.

There are several reasons commonly advanced as to why pigs prefer whole corn to ground corn: (1) the corn oil remains sweeter in whole corn; (2) owing to loss of moisture by evaporation, ground corn, after standing for some time, becomes harder and more brittle than whole corn.

For pigs under the conditions followed in this study, preparation by cooking was about the same as by soaking in the physiological effects upon the pigs. But cooking the ration cost more than soaking it. As shown in a previous paragraph, an unsoaked ration is the best.

Bolivar, in his experiment II for the same class of pigs, obtained results which gave the soaked ration a slight advantage over the unsoaked ration of the same grain mixture, a result which is just the reverse of that obtained in this work. In the present experiment the pigs were under grain-camote pasture system of feeding; Bolivar's pigs were under a more limited and poorer pasture (common grass pasture). But the lack of good green roughage in his work seemed to have been supplied in some way by soaking the ration. In the present experiment where bulk and succulence were supplied by the camote pasture, soaking the grain ration unduly increased the bulk of the feed and reduced the necessary amount of dry matter that could be ingested by the pigs.

These results would modify materially the conclusion of Bolivar in which he advised that corn, particularly of the flint variety, should be soaked before feeding it to growing pigs. His conclusion remains sound when applied to growing pigs under dry lot feeding or on limited or poor pasturage. The results for this period are shown in chart 1.

Second period

This period is a continuation of the first without alteration in the lots, system of feeding, or management. The only differences from the first period were in the ages of the pigs and the time of the year. The most outstanding results obtained during the second period are: (1) the unsoaked rations continued to give the best results; soaked rations held the second place more pronouncedly than in the first period; and the cooked rations slipped down to last place. (2) Lots III and VI on unsoaked rations and lot II on soaked whole ration made gains more economically than they did in the previous period and better than the rest of the lots in this period. (3) On the whole there seemed to be no material difference, as to their effect upon the growth of the pigs, between shelled corn and ground corn under similar preparations. If there was any difference, it was slightly in favor of ground corn; this was more strikingly shown by the results obtained from the unsoaked ration as represented by lot VI and lot III, than from the other rations treated otherwise. In Bolivar's work with pigs on cooked unground ration and on cooked ground ration there seemed to be an appreciable difference in favor of the former in the rate of gain made by the pigs. What caused this difference can not be accounted for in this study. In general the result obtained in this period showed the same tendency as that in the first period.

It is possible that the pigs were still, as in the first period, in a condition to make better use of the unsoaked ration than of the other preparations. That is, any preparation that tends to increase the bulk of the feeds, other things being equal, is less efficient than one which does not do so. It may be seen in table 2 that lots III and VI on unsoaked rations made an average daily gain per pig of .314 kgm.; lots II and V on soaked rations, .247 kgm.; and lots I and IV on cooked rations, .230 kgm. Conclusions on these figures: the last two preparations proved to be 36 per cent less efficient than the average of the lots on unsoaked rations, and 7 per cent less than those on the soaked rations. Chart 1 shows the progress in the development of the pigs in the different lots.

With respect to feeding corn in ground or shelled form there seemed to be a slight advantage secured from feeding it in the ground form. It may be recalled that from August 12 to 17 the camote pasture was practically exhausted so that the feeds were supplemented only by a depleted pasture. Under this temporary change of condition the lots on ground corn mixture made better use of the corn fed than those fed the unground. This is also the finding of Bolivar. Had the pigs been on good pasture during the entire period, probably, as in the first period, the lots on whole corn mixture would have continued to do better than those on ground corn.

As previously stated, cooking the ration continued to be the poorest preparation. Snyder (1899) explains this by stating that cooked ration, particularly if given with little or no green supplement and for a long period of feeding, is disadvantageous because of the loss, partly or wholly, of some of the elements as vitamin and albumen originally contained in the feed. Also, cooking the ration with copra meal as one of the constituents might have made it unpalatable, as the rancid oil from the meal would have a chance to permeate the feed. It is commonly known that unpalatability is not conducive to good digestion. Dr. E. B. Forbes says: "Palatability of food is important, (1) because it is one of nature's ways of indicating that food is good to eat, (2) because it incites the secretion of digestive juices, and so hastens the digestive process, (3) because it is a source of pleasure in eating, and (4) because it contributes a deep-seated and powerful motive in human life and action".[2] Only in special cases, as for weak or for very old or very young animals, is cooking generally recommended as of some benefit, and then for short periods only.

Third period

The same lots, system of feeding, and management were used as in other periods; the only difference was in the age of the pigs and the time of the year. The results, as in the previous periods, still showed that unsoaked rations gave the best results, soaked rations second, and cooked rations, least. From the standpoint of economy of gains made, rations with shelled corn gave better results than those with ground corn. On the other hand, from the point of view of rate in gains, there was a slight advantage in favor of rations with ground corn. In either case the difference was not marked. However, the difference in the results is rendered significant when it is noted that there was no exception in the results in all the lots under test.

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[2] Quoted by M. D. Helser, from Farm Meats. 1923. New York: The Macmillan Company.

Table 2 shows the results of the whole feeding period of 213 days. From the point of view of rate and economy of gains made the unsoaked rations proved the best, soaked rations second, and the cooked rations the poorest.

Between rations with shelled corn and ground corn, cooked rations excepted, there seemed to be some slight advantage in favor grinding corn if rapid rate of gains is to be specially considered; the reverse is true from the point of view of economy of gains made. With the cooked rations the one with shelled corn gave better results than the one with ground corn.

Chart 1 shows some minor crossing and recrossing, particularly between ground corn and whole corn lots, on rations similarly prepared in other respects. These crossings were due largely to the occurrence of oestrum in the females and temporary or minor ailments of one or more pigs at different times. The general or regular trend of each lot or of each preparation seemed to be fairly established. That is, unsoaked rations proved the best, soaked rations second, cooked rations third. Whole corn ration is more economical than ground corn ration, but ground corn ration appeared to induce faster rate of gains.

SUMMARY OF RESULTS

Table 2 shows the summary of results by lots of the whole feeding period of 213 days.

1. Of the different methods of preparations, the unsoaked rations gave the best results.
2. Soaked rations ranked second in results.
3. Cooked rations gave the poorest results.
4. In these three general preparations of rations, those having the corn in the shelled form, from the viewpoint of economy of gain, gave better results than those in the ground form. But from the viewpoint of rate of gain the rations with ground corn produced more rapid rate of gain than those with whole corn.

CONCLUSIONS

1. Pigs from 3-10 months of age in vigorous condition, on rations used in this experiment and on grain-camote pasture system of feeding, should be fed unsoaked rations.
2. Pigs placed under conditions similar to those in this experiment should be given whole corn in the ration instead of ground corn.
3. It is not advisable to cook rations for growing pigs, either in dry lot, limited or poor pasture, or even under grain-pasture system.

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TABLE 1

Showing summary of results of the first, second, and third periods of the experiment

Ration: 20 parts corn 60 parts rice bran 15 parts copra meal 5 parts dried shrimps	FIRST PERIOD FROM APRIL 4 TO JUNE 16, 1928					
	Shelled corn			Ground corn		
	Lot I cooked ration	Lot II soaked ration	Lot III unsoaked ration	Lot IV cooked ration	Lot V soaked ration	Lot VI unsoaked ration
Duration of the experiment	73 days	73 days	73 days	73 days	73 days	73 days
Number of pigs	6	6	6	6	6	6
Average age	3½ mo.	3½ mo.	3½ mo.	3½ mo.	3½ mo.	3½ mo.
Average initial weight of pigs	8.7166 kgm.	8.5333 kgm.	8.7666 kgm.	8.7000 kgm.	8.9500 kgm.	8.7000 kgm.
Average final weight of pigs	21.0000 “	18.5666 “	23.9666 “	20.1500 “	21.7166 “	23.2166 “
Average gain per pig	12.2833 “	10.04 “	15.2000 “	11.4500 “	12.7666 “	14.5166 “
Average daily gain per pig	0.1682 “	0.1363 “	0.2082 “	0.1568 “	0.1748 “	0.1988 “
Average daily feed consumption per pig	0.6433 “	0.5671 “	0.7280 “	0.6098 “	0.6255 “	0.7089 “
Grain to produce 1 kgm. gain	3.8236 “	4.1608 “	3.4967 “	3.8879 “	3.5770 “	3.5648 “
Cost of grain to produce 1 kgm. gain	₱0.2781	₱0.3026	₱0.2543	₱0.2828	₱0.2602	₱0.2593

Ration: 20 parts corn 60 parts rice bran 15 parts copra meal 5 parts dried shrimps	SECOND PERIOD FROM JUNE 16, TO AUGUST 25, 1928					
	Shelled corn			Ground corn		
	Lot I cooked ration	Lot II soaked ration	Lot III unsoaked ration	Lot IV cooked ration	Lot V soaked ration	Lot VI unsoaked ration
Duration of the experiment	70 days	70 days	70 days	70 days	70 days	70 days
Number of pigs	6	6	6	6	6	6
Average age	5¾ mo.	5¾ mo.	5¾ mo.	5¾ mo.	5¾ mo.	5¾ mo.
Average initial weight of pigs	21.0000 kgm.	18.5666 kgm.	23.9666 kgm.	20.1500 kgm.	21.7166 kgm.	23.2166 kgm.
Average final weight of pigs	37.8333 “	35.4333 “	44.6000 “	35.1666 “	39.3666 “	46.6000 “
Average gain per pig	16.8333 “	16.8666 “	20.6333 “	15.0166 “	17.6500 “	23.3833 “
Average daily gain per pig	0.2404 “	0.2409 “	0.2947 “	0.2145 “	0.2521 “	0.3340 “
Average daily feed consumption per pig	0.8983 “	0.8252 “	0.9559 “	0.8990 “	1.0478 “	1.0769 “
Grain to produce 1 kgm. gain	3.7356 “	3.4249 “	3.2431 “	4.1909 “	4.1558 “	3.2238 “
Cost of grain to produce 1 kgm. gain	₱0.2796	₱0.2563	₱0.2427	₱0.3134	₱0.3110	₱0.2412

Ration: 20 parts corn 60 parts rice bran 15 parts copra meal 5 parts dried shrimps	THIRD PERIOD FROM AUGUST 25 TO NOVEMBER 3, 1928					
	Shelled corn			Ground corn		
	Lot I cooked ration	Lot II soaked ration	Lot III unsoaked ration	Lot IV cooked ration	Lot V soaked ration	Lot VI unsoaked ration
Duration of the experiment	70 days	70 days	70 days	70 days	70 days	70 days
Number of pigs	6	6	6	6–(5)	6	6
Average age	8 mo.	8 mo.	8 mo.	8 mo.	8 mo.	8 mo.
Average initial weight of pigs	37.8333 kgm.	35.4333 kgm.	44.6000 kgm.	42.2000 kgm.	39.3666 kgm.	46.6000 kgm.
Average final weight of pigs	58.6833 “	63.4500 “	74.8500 “	61.7200 “	67.2000 “	75.2160 “
Average gain per pig	20.8500 “	28.0160 “	30.2500 “	19.7200 “	27.8333 “	28.6166 “
Average daily gain per pig	0.2978 “	0.4002 “	0.4321 “	0.2817 “	0.3976 “	0.4088 “
Average daily feed consumption per pig	1.2866 “	1.3009 “	1.3688 “	1.4828 “	1.3926 “	1.4119 “
Grain to produce 1 kgm. gain	4.3197 “	3.250[illegible] “	3.1674 “	5.2636 “	3.5023 “	3.4536 “
Cost of grain to produce 1 kgm. gain	₱0.3142	₱0.2364	₱0.2304	₱0.3829	₱0.2547	₱0.2512

TABLE 2

Showing summary of results by lots for the whole feeding period of 213 days

Ration: 20 parts corn 60 parts rice bran 15 parts copra meal 5 parts dried shrimps	SHELLED CORN			GROUND CORN		
	Lot I cooked ration	Lot II soaked ration	Lot III unsoaked ration	Lot IV cooked ration	Lot V soaked ration	Lot VI unsoaked ration
Duration of the experiment	213 days	213 days	213 days	213 days	213 days	213 days
Number of pigs	6	6	6	6	6	6
Average initial weight of pigs	8.7166 kgm.	8.5333 kgm.	8.7666 kgm.	8.7000 kgm.	8.9500 kgm.	8.7000 kgm.
Average final weight of pigs	58.6833 "	63.4500 "	74.8500 "	61.7200 "	67.2000 "	75.2160 "
Average gain of pigs	49.9667 "	54.9167 "	66.0834 "	53.0200 "	58.2500 "	66.5160 "
Average daily gain of pigs	0.2346 "	0.2578 "	0.3102 "	0.2176 "	0.2735 "	0.3123 "
Total grain feed consumed by lot	1199.5000 "	1141.4000 "	1295.3000 "	1163.7000 "	1299.0000 "	1355.8000 "
Total cost of grain consumed	₱88.0556	₱83.7645	₱95.0758	₱85.4518	₱95.4261	₱99.5840
Average daily grain per pig	0.9385 kgm.	0.8931 kgm.	1.0135 kgm.	0.9633 kgm.	1.0164 kgm.	1.0609 kgm.
Grain feed consumed 1 kgm. gain	4.0010 "	3.4693 "	3.2668 "	4.5248 "	3.7167 "	3.3971 "
Grain feed consumed per 100 kgm. gain	400.1000 "	346.9300 "	326.6834 "	452.4864 "	371.6738 "	339.7144 "
Cost of grain to produce 100 kgm. gain	₱29.3714	₱25.4603	₱23.9785	₱33.2125	₱27.3033	₱24.9518

ABSTRACT[1]

Relation of age of farm crop seeds to production. FILEMON P. LEUS (*Thesis presented for graduation from the College of Agriculture* No. 321; Experiment Station contribution, No. 682). In this study the object was to determine the relation of age of farm crop seeds to production. Four kinds of seeds of different ages were used: Corn 3, 7, 8, 12, 13, 18, and 32 months old; cowpea 3, 8, 18, and 32 months old; mungo 3, 8, 12, 18, and 32 months old; soybean 8, 19, and 32 months old.

Laboratory and field experiments were conducted. In the laboratory, 25 seeds of different ages of each kind were planted in boxes that contained fine sand and soil. In the field, rainy and dry season cultures were planted.

In the laboratory:

1. Corn: seeds 8, 18, and 32 months old gave 100 per cent germination; the seeds 12 months old (rainy season harvest) gave poor germination.
2. Cowpea: seeds 8 and 32 months old gave 100 per cent germination and the seeds 18 months old gave 84 per cent.
3. Mungo: seeds 8 and 12 months old gave 76 per cent germination; the seeds 18 months old gave 92 per cent and the seeds 32 months old gave 96 per cent.
4. Soybean: seeds, 8 and 19 months old gave 68 per cent; seeds, 32 months old gave 56 per cent.

In the field wet season culture:

1. Corn: seeds 3 months old gave 90.8 per cent germination and 68.81 grams of ears to the hill; seeds 13 months old gave 91.16 per cent germination and 84.79±3.09 grams.
2. Cowpea: seeds, 3 months old gave 96.24 per cent germination and 66.90±1.50 grams of vine to the hill; seeds, 13 months old gave 82.12 per cent and 57.94±1.06 grams of vine to the hill.
3. Mungo: seeds, 3 months old gave 42.21 per cent and 39.98±0.95 grams to the hill; 13 months old gave 58.87 per cent and 46.37±1.01 grams of vine to the hill.
4. Soybean seeds behaved in a manner similar to that of the cowpea seeds.

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[1] Abstract prepared as part of required work in English 6, College of Agriculture.

In the dry season crop, the oldest corn seeds produced the highest production of ears to the hill, 93.68±1.94 grams; the seeds 13 months old gave 68.73±1.83 grams. Cowpea, mungo, and soybean plants behaved in a manner similar to those of the wet season crop. The seeds 8 months old gave higher production of grains to the hill than the seeds 18 months old

—Abstract by Martin S. Celino.

THINGS THAT ENDURE

Honor and truth and manhood—
These are the things that stand
Though the sneer and jibe of the cynic tribe
Are loud through the width of the land.
The scoffer may lord it an hour on earth,
And a lie may live for a day.
But truth and honor and manly worth
Are things that endure alway.

Courage and toil and service,
Old, yet forever new—
These are the rock that abides the shock
And holds through the storm, flint-true.
Fad and folly, the whims of an hour,
May bicker and rant and shrill;
But the living granite of truth will tower
Long after their rage is still.

Labor and love and virtue—
Time does not dim their glow;
Though the smart may say, in their languid way,
"Oh, we've outgrown all that, you know!"
But a lie, whatever the guise it wears,
Is a lie as it was of yore.
And a truth that has lasted a million years
Is good for a million more!

—FROM DEAN BAKER'S SCRAPBOOK.

EXCHANGE NOTES

In these enlightened days of scientific research, when entomologists are so fond of voicing the merits of biological control, we are, perhaps, inclined to dwell too much upon the entomological side of the question and not enough on the advantages to be derived from a closer study of our insectivorous birds and their habits.

Although the percentage of cane pests is probably small in comparison with that accounted for by parasitic and predaceous insect enemies—which attack not only the adults but also their eggs, larvae, and pupae—we should not forget that the services rendered by birds in helping to maintain what is known as the balance of nature cannot be too highly valued by the man on the land.

In the year 1914, when reporting on the sheep-maggot fly pest in Western Queensland, I noticed that the question of bird preservation was intimately associated with the trouble, and that, as a general rule, timbered country or scrub land affording shelter for bird life was free from or but slightly infested by sheep-maggot flies—whilst on extensive areas devoid of trees the pest was generally at its worst. This was very noticeable both at Longreach and Emerald; those portions supporting timber being usually free from the fly, but the adjoining cleared open areas generally infested.

Probably much of the land at present devoted to the cultivation of sugar-cane in Queensland (exceeding 224,000 acres) was originally more or less timbered country. After being cleared and planted, however, conditions very similar to those obtaining in the west with regard to bird life would naturally tend to become established throughout most of our cane land.

Deprived of suitable shelter and facilities for nesting, and forced, therefore, to retire from tracts of country on which they had been breeding in the past, the services of many of our useful insectivorous birds have been practically lost to us. To make matters worse, itinerant so-called sportsmen continue to invade bird sanctuaries, and often, for the mere lust of killing, blow to pieces every little songster they may chance to hear. Such crass ignorance is lamentable, and admittedly a crime against humanity at large, seeing that posterity is being robbed by us in this manner of certain beautiful species of the animal kingdom which once destroyed can never be replaced. Incredible as it may seem, one occasionally hears reports of the shooting of ibises and other grub-eating birds for food by some of our own cane-growers. Such foolish slaughter, if continued, must eventually lead to several of these feathered friends avoiding the neighborhood of canefields and feeding elsewhere. Fifteen years ago it was a common sight to see flocks of the "Straw-necked ibis" (*Carphibis spinicollis*) in cane lands around Gordonvale and Highleigh picking up grubs behind the plough; but now only one or two specimens are noticed at work in a field, and in some localities this valuable bird appears to have disappeared altogether.

—*Queensland Agricultural Journal.*

Dr. McCarrison has brought forward evidence in the *Indian Journal of Medical Research* that some difference in the nutritive value of crops—quite apart from yield—may be observed according to the conditions of water supply of the crops while growing. For rice he states:—

(1) The nutritive value of rice is influenced by the conditions of water supply under which the crop is grown;

(2) Rice grown on puddled fields in which a layer of water is always allowed to remain has a nutritive value approximately one-third less than the same rice when grown under dry rain-fed conditions;

(3) The lower nutritive value of rice grown under wet conditions is due, in part at least, to its lower content of vitamins of the water-soluble—B class; and

(4) It seems probable that the conditions of cultivation of rice, especially in regard to water supply during the growth of the crop, is a factor of importance in determining the endemicity of beriberi.

—*The Planter.*

We have had a request for information on the manufacture of tapioca. First of all, it is necessary to be sure what is tapioca. At many of the Shows where classes are made for tapioca it is customary for people to present cassava meal. Cassava meal is the result of grating the bitter cassava as a rule, squeezing the juice out of it under press and drying the residue. Tapioca is made from the starch, the process being as follows: The bitter cassava is grated, the pulp is then thoroughly washed, using plenty of water, the washings being run into a collecting vessel in which it is allowed to settle and the water is then poured off, leaving the starch behind still damp. This starch is placed on hot plates and stirred, the heat bursting the starch globules and causing a glutination, that is a holding together of the starch into little lumps, which is tapioca.

A spoonful of this stuff stirred into a custard and then baked makes quite a delightful pudding. It may also be boiled and milk added, making gruel for invalids and infants.

Tapioca will keep almost indefinitely as long as it is thoroughly dried and kept in a closed vessel.

—*The Journal of the Jamaica Agricultural Society.*

COLLEGE AND ALUMNI NOTES

By invitation of José K. Santos, head of the Department of Botany, College of Liberal Arts, on September 6, Baker Memorial Professor F. L. Stevens delivered an illustrated lecture on "The effect of ultra violet irradiation on fungi" in the Botany Lecture Room of Rizal Hall, University of the Philippines, Manila.

In the last days of August, U. S. Trade Commissioner Evett D. Hester and Dean B. M. Gonzalez of the College of Agriculture made a three-day trip to the coconut regions of Laguna and Tayabas for the purpose of ascertaining the extent of the present depression caused by the low prices of coconut products and the damage by the leaf-miner. They report that while the combined effect of low prices and the leaf-miner have caused a depression in prosperity ranging from 20 to 60 per cent when 1929 is considered as normal, apparently the depression is not affecting seriously the bulk of the population. This is largely because the price of rice, an important crop in this locality, is considerably lower than last year, mitigating largely the effect of the depression.

Dr. F. L. Stevens gave the third of the series of semi-popular lectures on the evening of September 3, on the subject of Porto Rico and Hawaii. The physiography of these two tropical regions was the principal theme of a most instructive and entertaining lecture. Interest was increased by the many lantern slides which were of special value in making real the volcanoes in Hawaii.

Mr. H. Atherton Lee, Director of Research of the Philippine Sugar Association, accompanied by Mr. J. D. Hunger, a provincial governor of Java, Dr. A. L. Dean, former President of the University of Hawaii, and Mr. Lyman Dean, son of Doctor Dean, visited the College on September 4, 1930. They were particularly interested in the sugar course, sugar cane and pineapple breeding, and the insect pest and diseases of sugar cane, as well as in the sugar cane soils work of the College.

A letter received by Baker Memorial Professor F. L. Stevens from Professor Hottes, Head, Department of Botany, University of Illinois, states that Dr. Bjorn Palm, a Dutch botanist who had been in Buitenzorg, Java, is taking the place of Doctor Stevens in College of Liberal Arts during the incumbency of the latter as Baker Memorial Professor (1930-1931).

The last issue of the *Makiling Echo*, the quarterly publication of the Bureau of Forestry, is the School of Forestry Twentieth Anniversary number. With a fine picture of Mount Makiling on the green cover page, the journal is most attractive in appearance. Among the many interesting articles is "The College of Agriculture" by Dean B. M. Gonzalez in which the development of the college is succinctly presented.

THE PHILIPPINE AGRICULTURIST acknowledges the announcement sent by courtesy of the Director of Agriculture, C. S. Lin, of the organization of the Bureau of Agriculture and Forestry under the Department of Reconstruction, Kwantung Province, China. The announcement states that the aim of the bureau is the increase of food production and improvement of the welfare of the rural population.

At the meeting of the Los Baños Biological Club on the evening of August 28, in the Lecture Hall of the Department of Agricultural Chemistry the following papers were read and discussed:

"Increased diameter growth of bagtikan (*Parashorea malaanonan* Merr.) after release from seed, nurse or wolf trees." By Forester Carlos Sulit.

"Age determination in ox reared under Philippine conditions." By Dr. M. Manresa and Messrs. F. B. Sarao, C. Tuason, T. Pepito, and E. Agudo.

Read by Doctor Manresa.

Dr. José B. Juliano has just returned to the College after two years of study in Leland Standford Jr. University, majoring in plant morphology with ecology and taxonomy as minor subjects. He was granted degree of Ph. D. in June, 1930. Doctor Juliano will teach the morphology and ecology courses in the College of Agriculture and will be in charge of the Herbarium, and Arboretum.

The Faculty Committee on Molawin Hall announces the opening of a Guest House. This house is the cottage formerly occupied by the doctor's office. It has been remodeled making an attractive house with sala, three sleeping rooms and one bathroom.

The rate is one peso a day. Meals can be obtained at the Molawin Hall restaurant across the street.

Any guest desiring to stay longer than fifteen days must obtain permission from the Dean of the College.

The U. P. Rural High School Faculty is represented in student affairs by Mr. Robin as Adviser in Student Congress and Assembly; Mr. Costa is the Athletic Representative, and Miss Denny has charge of the girls' club work.

The A. W. S. (Associated Women Students of Los Baños) elected the following officers who will serve throughout the year.

President	Mamerta Manahan
Vice-President	Victoria Mendiola
Secretary	Purificación Caguicla
Treasurer	Felipa Belo

The new shop and tool room is nearing completion in the U. P. R. H. S. reservation.

Mrs. Arnaldo has resigned as teacher in Makiling School because of illness in her family. Miss Lina Velmonte, a College of Education senior, has been selected to fill the vacancy.

The Mimics presented their first program of the year in the College Auditorium the evening of August 30.

A departure from previous years was a diversity in the main attractions on the program.

The one-act play, "The Trysting Place," by Booth Tarkington was the principal feature. This humorous bit of life with its clever lines and mirth-provoking action was admirably presented by the following cast:

Mrs. Curtis, A young widow	Andrés Caranto
Mrs. Briggs, A widow with two children	Phisitinksavanya
Launcelot Briggs, Young son of Mrs. Briggs	José Quintos
Jessie Briggs, Sister of Launcelot	Martin Rosell
Rupert Smith, Suitor of Jessie	Domingo Regner
Henry Ingoldsby, Former fiancé of Mrs. Briggs	Francisco Franada
A Mysterious Voice,	Calo Bedelles

The thrill of the evening was the playing of the women's parts by men. This departure indicates progress in the Mimics. And the finish of the young men's acting revealed the value of the weekly hour of study for the past two years under the faithful and able direction of Miss Cole. Popular opinion on the campus is that "The Trysting Place" was the most finished production that the Mimics has offered.

An exhibition of Siamese boxing was the second feature of the evening. The stage had been converted into a "sure enough" boxing ring. The exhibition was given with spirit and technique. As the action and rules of Siamese boxing are very different from Western boxing the exhibition was watched with great interest by the audience. Both "light-weights" and officials and attendants were Siamese students. Siamese "boxing" music played on Siamese instruments added to the spirit of the exhibition.

Solos by Miss Mamerta Manahan and by Mr. Fernando Fernandez, as always, gave much pleasure to their old friends. By request, Miss Mamerta Manahan sang, "They are always abusing the women" (words by Aristophanes) and Mr. Fernando Fernandez, "Believe me if all those endearing young Charms". Both songs were sung in the "Cadets' Sweethearts" presented in 1929. Prof. M. A. Roa at the piano and B. Dableo on the violin were accompanists.

CHRISTMAS IN THE STABLE

On Christmas night when the bells delight,
And good will to man beseech,
As years are old the legend is told
That the quadrupeds have speech.
At twelve o'clock by the crow of the cock,
In the stables o'er the land,
From lips ere dumb there is heard a hum—
A babble of voices bland.

Said bossy cow, as she made her bow,
"I am sure you'll not deny,
Though to your ear it may sound quite queer,
There is none so useful as I.
My muscles make tender, juicy steak,
And my hide for shoes they tan;
My milk and cream daily flow in stream,
For the food of babe and man."

Said grunty pig, "I don't care a fig,
What the rest of you may say,
I am the beast that graces the feast
On this bright and festive day.
A morsel sweet from my head to feet,
I create new appetite;
My tender flesh either cured or fresh
Is my master's chief delight."

And woolly sheep, as he woke from sleep,
Lent his voice in self praise, too.
Said he, "My breed is a pride, indeed,
Wether, lamb, or buck or ewe.
'Tis positive that threefold I give,
In leather, in clothes, in meat.
So I contend I am man's best friend,
'Tis a fact they oft repeat."

Then spoke old bay, with a gentle neigh,
As he shook his halter rope,
"You've all made claim to some valued fame,
And you're satisfied, I note.
Now list to me, since our words are free,
While a tale to you I tell,
Then without grudge I will let you judge
As a friend why I excel.

"Here I was born on a summer morn,
And the scent of new-mown hay
Came floating by as I cast an eye
On a wonder world that day.
The seasons flew and I quickly grew
To a sound and prancing steed,
And far and wide o'er the countryside,
Not a match had I in speed.

"A lad as kind as e'er one will find,
'Twas my destiny to serve.
Each slight command of his voice or hand
Tingled through my blood and nerve.
I set the pace for many a race
Through the vale and o'er the hill,
A rapid clip without spur or whip
'Neath a rider's guiding skill.

"He hummed a song, I cantered along,
On an autumn morning fair;
My well-shod feet in rhythmic beat,
My nostrils wide to the frosty air.
A sudden alarm, a tightened arm,
An anxious halt, a listening ear,
And clear and plain it was heard again
A desolate cry of fear.

"A leap, a bound, at that distress sound,
There's a human life at stake.
With a vim and dash I'm off like a flash,
A maddened beast we must overtake.
A whispered cheer as I gallop near,
A gentle urge and a final spurt,
The race is won, and the gallant task done,
And a maiden smiles, unhurt.

"A single glance kindles love's romance,
So the fates do oft foretell.
A courtship gay and a wedding day
Brought the maiden here to dwell.
And since that time when the carols chime,
On this night of cheerfulness,
I, too, rejoice in my humble voice,
In my master's happiness.

"I must take heed of the hour's speed,
So my story's to an end.
Please signify if I qualify
To be man's most faithful friend?"
Thus asked old bay—but there's no gainsay,
For the time of speech was spent;
And from the herd not a sound was heard,
So their silence gave assent.—T. P. White.

—*Journal of the American Veterinary Association.*

SILAGE FOR DAIRY AND WORK ANIMALS IN THE PHILIPPINES[1]

FELIX B. SARAO AND JOSE P. ESGUERRA
Of the Department of Animal Husbandry

WITH THREE TEXT FIGURES

As man rises from a lower to a higher level of civilization he gives more and more thought to his future; he realizes with increasing interest the necessity for storing food while it is abundant for his future use when it is scarce. This concern about the future has given rise to continuous search by man for better means of preserving food not only for himself but also for his domestic animals.

Silage is one of the preserved feeds for animals. It is fodder, such as corn, alfalfa, sorghum, and the like preserved. While still green and fresh these plants are cut into small pieces and preserved by compressing them in a pit or cistern called a silo. In temperate countries, silage is used for feeding mainly during the winter when the pasture is covered with ice and snow, or during the long summer when the pasture becomes too dry to produce sufficient grass.

According to Henry and Morrison (1923)[2] the preservation of beet leaves and beet waste and other green forage by gathering it into heaps or into earthen pits was practiced in Europe long before the first silo was built in the United States in 1873. Today, perhaps there is no other country in the world that uses as many silos or produces as much silage as the United States does. The experience of the dairy farmers in the United States and other countries during the last forty years has shown them that silage is an economical feed for dairy cattle. It can also be said with safety that the great majority of the dairy farms in the United States could not be run without silage. So essential has this feed become that a silo is now a part of the equipment on all dairy farms; and feeders of beef cattle are finding that they have to use silage more and more.

INTRODUCTION OF SILO AND SILAGE MAKING IN THE PHILIPPINES

The Philippine Bureau of Agriculture, influenced by the success which the United States was having with the use of silage, constructed in 1912-1913 at Alabang Stock Farm, Rizal, the first silo in the Philippines. This silo is made of concrete. It has a diameter of 4.88 meters (16 feet) and a height of 6.10 meters (20 feet). The writers were told that this silo has not been in use for the past ten years. According to Mr. Alfonso Tuason of the Bureau of Animal Industry[3] the one time that this silo was filled, using as materials a mixture of sorghum, sugar cane, cogon, and aguiñgay, it produced good silage.

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[1] Experiment Station contribution No. 686. Received for publication July 21, 1930.

[2] Henry, W. A., and F. B. Morrison. 1923. Feeds and feeding. 8th ed., VI+770 p., 190 fig. Madison: The Henry-Morrison Company.

In the College of Agriculture there was an attempt at silage making long before the College silo was constructed. Some thirteen years ago Dean B. M. Gonzalez, who was then Instructor in Animal Husbandry, successfully demonstrated to his students that it is possible to make silage of good quality by using only a cylindrical glass jar. Encouraged by his experience in silage making while studying in the United States and by the results obtained from his experiments in the Philippines, Doctor Gonzalez decided to have a silo in this College. He had long foreseen the necessity of supplementing our pasture during the dry season. Knowing, however,

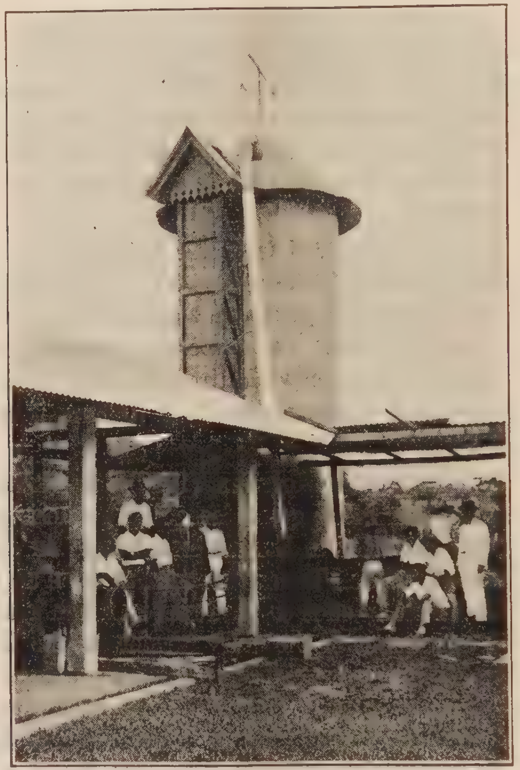

Fig. 1.—The College silo at the time of filling.

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[3] In 1929 the Philippine Bureau of Agriculture was reorganized into the Bureau of Animal Industry and the Bureau of Plant Industry.

that the need for a silo was not immediate, and being rather suspicious as to why the silo at Alabang had not been in use for years, the steps taken towards the construction of a College silo were rather slow and hesitating. The plan was carefully studied, especially the height and diameter that would give the proper compactness of the silage, a condition very essential for its proper preservation.

In the early part of March, 1928, the first silo in the College of Agriculture, and the second one in the Philippines, was completed. (See fig. 1.) The College silo, like the one in Alabang, is made of concrete. It is 8.23 meters (27 feet) high, and has a diameter of 2.44 meters (8 feet). The capacity was estimated to be about 22 tons of silage. This silo was first filled on August 24, 1928, with corn fodder. Owing to lack of material it was filled only to the height of 3.66 meters (12 feet). The top was sealed with about 6 gantas (10.32 kgm.) of germinating palay; the silage was not opened until April 2, 1929, a little over seven months later. When the spoiled portion on the top, which was a layer of a little over 30 centimeters thick, was removed, the brownish-green corn silage appeared. The sweetish acrid smell, which only perfectly preserved silage gives, filled the air at once and helped confirm the examiner's opinion, based on the appearance, that the silage was undoubtedly good.

FEEDING OF SILAGE AT THE COLLEGE OF AGRICULTURE

The first silage produced, which amounted to about 6,411 kilograms or approximately 7.5 tons, was fed from April 2 to May 26, 1929, to the College dairy herd which, on the average, consisted during this period of 8 head of cattle and 12 head of water buffaloes. At first, only two kilograms or less were given to the cattle and three kilograms to the water buffaloes. This amount was gradually increased until on the fourth day the cattle were allowed to consume as much as four kilograms, and the water buffaloes, six kilograms. Each calf in the herd received a share.

In the early days of feeding silage it was observed that while a large majority of the animals relished it from the first, others ate it with some degree of reluctance, and two oxen and two water buffaloes would not even taste it. However, by mixing a little salt with the silage these four animals were taught to eat it in less than three days. In less than a week all the animals in the herd learned to like the silage so much that every time the silo was opened and the silage thrown down through the chute one could see the saliva coming out of their mouths as they turned their noses towards the silo and deeply inhaled the silage-scented air while eagerly waiting for the coming of the much-liked new feed—the corn silage. (See fig. 2 and 3.)

The summer of 1929 was one of the longest and dryest summers in Los Baños of which there is any record. From the early part of February to the end of May the College pastures were almost dry. Because of lack of enough grass to eat in the pasture where they spent about 15 hours, when the animals were brought in in the morning, they were hungry. Had it not been for the corn silage it would have been impossible for the College to keep its animals milking and maintained in fairly good condition. Although there was every indication that they could consume more silage, for fear that it might run short before the summer ended the cattle were not given more than 4.5 kilograms a head and the water buffaloes, 6 kilograms.

By feeding about 130 kilograms of silage every day, which removed from the silo a layer of about 5 centimeters, (2 inches) it was possible to prevent the spoiling of the top of the silage. There was practically no spoilage found at the bottom.

Fig. 2.—College dairy cows reaching for some more corn silage.

So gratifying were the results obtained from the first silage feeding that the silo was refilled to capacity on August 7, 1929, to prepare for the summer of 1930. This silage, which amounted to about 16,201 kilograms, or about 17.8 tons, was better than that of the year before. It was fed from March 1 to June 26, 1930, about four months.

To provide silage for a greater number of animals, including the work bullocks, another silo of greater capacity is now under construction and is fast nearing completion.

WHAT IS THE SIGNIFICANCE OF THIS SUCCESS IN PRODUCING SILAGE IN THE PHILIPPINES

As it has in other parts of the world, the use of silage is bound to revolutionize stock feeding in the Philippines. In the United States, experiments have conclusively shown that "the silo provides high quality succulent feed for any season of the year, with a low expense for labor and a minimum wastage of nutrients". Especially for dairy cattle and work animals that have to be kept near the barns, silage is a convenient, nutritious, and economical feed. In the Philippines the first places that will fully appreciate the true value of silage feeding are not those sparsely populated regions where the extensive uncultivated lands yield more grass than their small number of live stock can consume during the dry part of the year, but rather those more thickly inhabited provinces, as Batangas, Cebu, and the Ilocos where practically all of the land is under cultivation and where many animals have to be fed to maintain the supply of power, meat and milk and other animal products. In these places while it may be possible for the farmers to have more than enough feed for their animals during the wet season when grass grows luxuriantly they do not have enough during the dry season. Such a condition exists in many parts of the Islands as it does in the College of Agriculture.

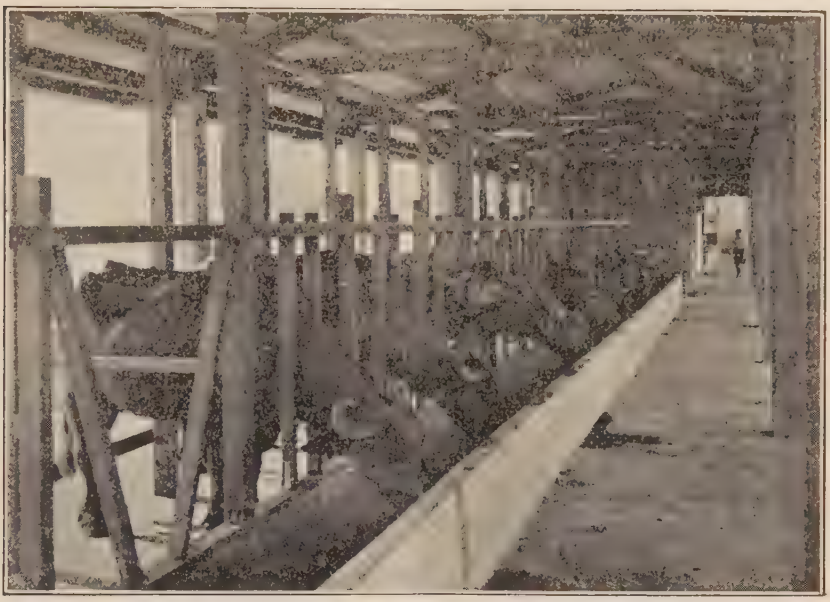

Fig. 3.—College water buffaloes feeding on corn silage.

What can be done about it? The College of Agriculture has shown that the situation can be met by using silage. Whether the practice will be adopted by the farmers in the thickly populated regions remains to be seen. In addition to supplying feed, the supplementing of the pasture with silage during the dry season not only insures the health and life of the animals but it also protects the pasture from becoming depleted beyond immediate recuperation.

OBSERVATIONS ON THE PHILIPPINE WEAVER, MUNIA JAGORI MARTENS I: BREEDING AND ASSOCIATIONAL HABITS[1, 2]

CANUTO G. MANUEL
Of the Department of Entomology

WITH FOUR CHARTS AND FIVE TEXT FIGURES

The Philippine weavers have always been regarded as destructive to rice; they can be seen in flocks of hundreds hovering over rice fields when the grain is in head. As there is usually only one, or at most two, rice seasons in many parts of the Islands, naturally these birds have to tide over between seasons on other plant foods.

Fig. 1.—Close view of a nest of *Munia jagori* in an association of *Pennisetum merkerii.*

Authorities seem to agree that *Munia jagori* is endemic to the Philippines. It is locally known as *mayang pula* or *mayang dampol* (Tagalog), *denas paking* (Pampango), *anuyao* (Pangasinan), *bilit toling* (Ilocano), *maya*

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[1] Experiment Station contribution No. 687. Received for publication September 29, 1930.

[2] Family Ploceidae, subfamily Viduinae.

pula (Ilongo), and *maya* (Cebuano). Students in the College of Agriculture from different regions of Mindanao, including the Mohammedan parts, have informed the writer that *maya* is the general name for this species in that island.

Bartholomew, Clarke, and Grimshaw (1911) report that the members of the subfamily Viduinae, to which the Philippine weaver belongs, are distributed throughout the Ethiopian, Oriental, and Australian regions, especially where rice is grown. Sharpe (1890) notes that the geographical distribution of the genus *Munia* is coextensive with that of the subfamily. Except for a very closely allied species which has been recorded elsewhere, *Munia jagori* so far is known only in the Philippines. Bartlett (1888-89) gives the name of the bird in English, German, and French, and cites the Philippine Archipelago as its habitat. McGregor (1909) records its occurrence in the following islands of the archipelago: Balabac, Bantayan, Banton, Batan, Basilan, Bohol, Bongao, Cagayan, Sulu, Calamianes, Calayan, Catanduanes, Cebu, Fuga, Guimaras, Leyte, Lubang, Luzon, Masbate, Mindanao, Mindoro, Negros, Palawan, Panay, Polillo, Romblon, Samar, Semirara, Sibay, Sibuyan, Siquijor, Sulu, Tablas, Tawi Tawi, and Ticao. In the Malay Peninsula and the Greater Sunda Islands, except Java, there occurs an allied form, *Munia atricapilla* Vieill., which differs from *M. jagori* in only such minor characters that Dammerman (1929, p. 298) expresses the belief that the latter is only a subspecies of the former.

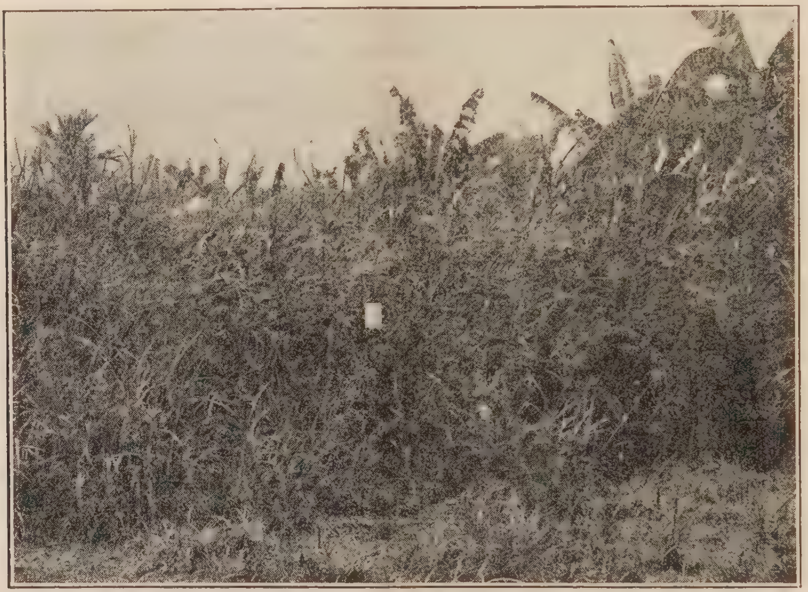

Fig. 2.—A field of *Pennisetum merkerii*, showing an ideal place for nest-building.

The present work had for its objects the study of: (*a*) the breeding habits of *M. jagori*, including nest building; (*b*) development of the young; and (*c*) associational habits of the adults and composition of flocks.

A period of about two years, from December, 1926, to June, 1928, was devoted to this study and to collecting materials for observation of the food habits of *M. jagori*.

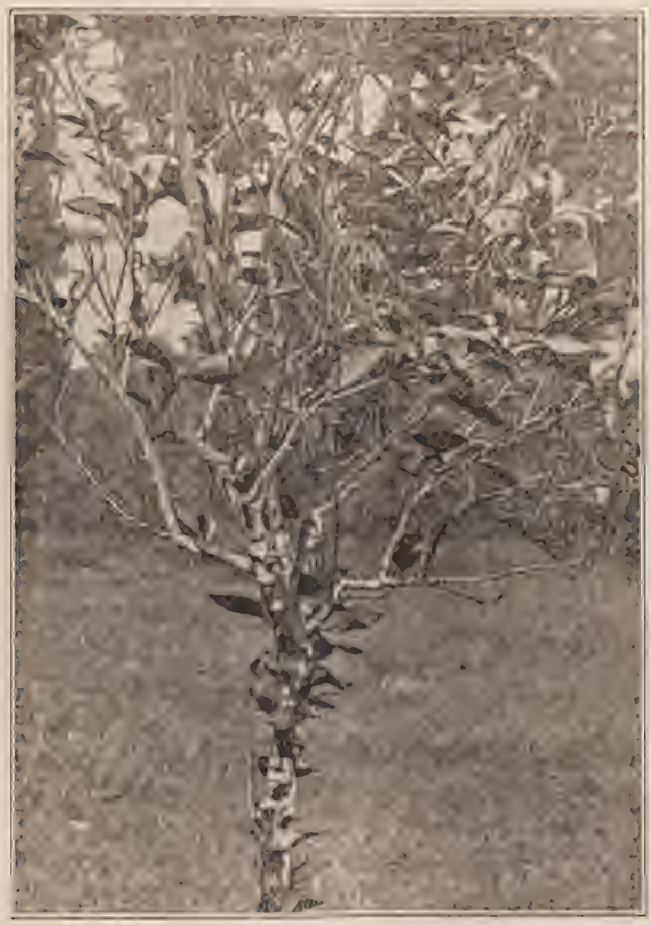

Fig. 3.—A nest of *Munia jagori* in a citrus tree. The increasing weights of the nestlings have distended the opening of the nest.

BREEDING HABITS

There is not a clear externally distinguishable criterion by which the male may be distinguished from the female.

McGregor (1909) noted the relative sizes of the two sexes as follows: Male, length, 120; wing expanse, 54; tail, 39; culmen from base, 11; tarsus,

16. Female, wing expanse, 54; tail, 38; culmen from base, 10; tarsus, 13. Sharpe (1890) described the two sexes based on the specimens he had seen in the Whitehead, Forbes, and Tweeddale collections. The differences, however, pointed out by these two authors did not prove useful in the present investigations. The writer in the course of his work noted a rough guide which was found convenient in telling the two sexes apart; namely, the characteristic colors of the head (lore, crown, hind head), which in the male is blackish brown and in the female, clove brown. It should be pointed out, however, that, except during the breeding season, this difference in color is not very marked and would undoubtedly baffle a beginner. This criterion was further supplemented by the appearance of the vent, which, especially during the breeding season, is conspicuously more swollen in the sexually mature female than in the corresponding male.

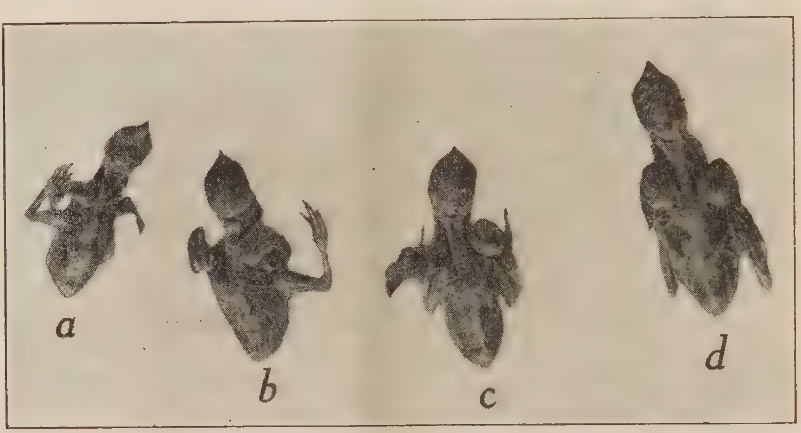

Fig. 4.—Young nestlings of *Munia jagori*. *a*, six days old; *b*, seven; *c*, eight; *d*, nine.

For more than two years the writer made unsuccessful attempts to observe the weavers in copula. Although no precise data regarding their mating habits were obtained, the writer suspects that copulation takes place at rest. The birds were observed in that position to isolate themselves in pairs, one of the two, presumally the male, biting the female

The nesting season in Los Baños Municipality and vicinity was observed to begin the latter part of March and end in the early part of October; but the greatest activity was from May, the beginning of the rainy season, to the early part of August. The flowering of certain species of grasses and subsequent production of seeds may in part account for this condition; the arrow heads of grasses furnish material for nest building and the seeds for feeding weaver nestlings.

The nests are generally built in groups, that is a number form a little settlement as it were, although isolated nests are not uncommon. The nests are built from about fifty centimeters to about three meters above the ground. The nests of the Philippine weaver were seen on the following plants:[3]

FAMILY NAME	SCIENTIFIC NAME	COMMON NAME
1. Gramineae..........	*Imperata cylindrica* (Linn.) Beauv.	cogon (Tagalog)
	Saccharum officinarum Linn.	uba cane
	Pennisetum merkerii..................	merker grass
	Saccharum spontaneum Linn.	talahib (Tagalog)
2. Pandanaceae........	*Pandanus* sp.	pandan
3. Combretaceae.......	*Terminalia catappa* L.	talisay (Tagalog)
4. Rutaceae...........	*Citrus* spp.	citrus
5. Moraceae...........	*Ficus hauili* Blanco..................	hauili (Tagalog)

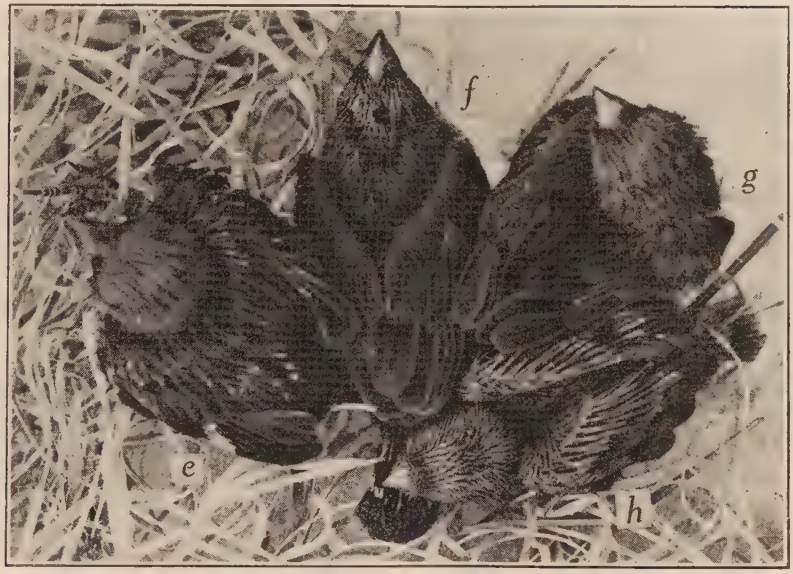

Fig. 5.—Older nestlings of *Munia jagori; e*, seventeen days old; *f*, eighteen; *g*, sixteen; *h*, fifteen.

On *T. catappa*, nine nests were seen within a radius of about two and a half meters. In a patch of *I. cylindrica* of about four square meters surrounded with maguey, *Agave cantula* Roxb. six nests were seen. In one instance nine nests were noted on a citrus plant. During the earlier part of the breeding season nests were noted on citrus plants which were located near together. Such proximity indicates the extent to which associational instincts are manifest even in nest building.

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[3] The Royal palm (*Oreodoxa regia* HBK), anilao (*Columbia serratifolia* (Cav.) Pers.), and other trees have also been frequently observed on the College campus to harbor weaver nests; and in Calamba, Laguna Province, camuning (*Murraya exotica* L.). Evidently habits or associational characteristics of plants, rather than any intrinsic attribute of a given plant species, determine this bird's choice of nesting sites.—L. B. U.

When the nest was built among grasses, it was found surrounded by materials identical with those in the nest, evidently for the purpose of protection. Patches, or areas of tall, thick grasses, were observed to be preferred always to low and thin species. Nests were also observed on *Pandanus* sp. that was surrounded by low growing cogon. That many nests were found built on an isolated *T. catappa* may indicate either that this tree is a favorite nest location for the weavers or that for some special reason many birds happened to use it this one year. The site, however, struck the writer as quite unique in that not only was the ground surrounding the base of the tree free from thick undergrowth but also there were no inhabited houses in the neighborhood. On citrus the nest was found always on low branches so that one could readily distinguish it from the nest of the related species, *M. cabanisi* Sharpe, which always builds its nest in tree tops. In Calamba Island, a place with an area of about three hectares, a nest was found on *Ficus hauili*. The crown of the tree where the nest was seen overtopped the surrounding cogon growth. In that island, there was only one house, which was located at the end opposite that where the nest was found. This fact may account for the bird's building its nest on the more exposed *Ficus* crown rather than among the *Imperata cylindrica* which abounds in that place.

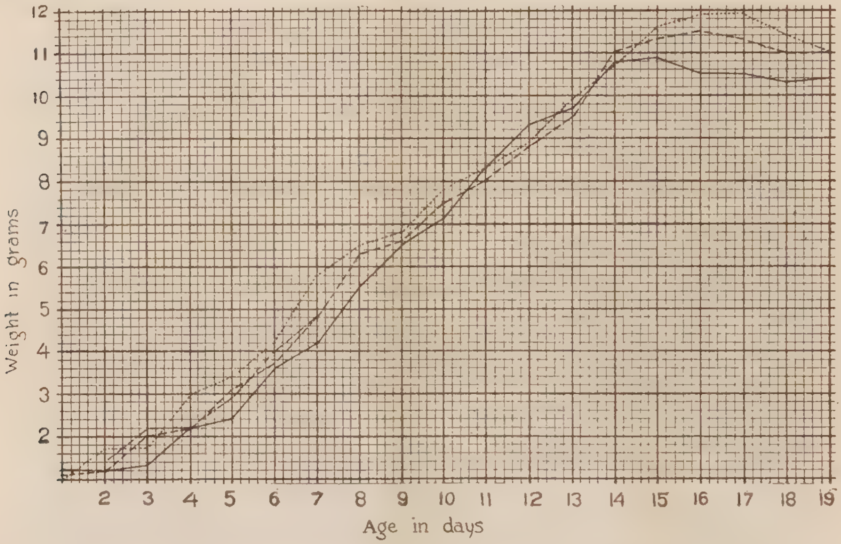

Chart 1.—Showing rate of growth by weight of four nestlings from nest 1.

The nest, which is subglobular and open at one end of its long axis, is suspended against either the leaves or the twigs of the plant where it is built in such a way that an ordinary typhoon cannot disturb it. The long axis of the nest is always horizontal to the ground so that the bird can go in and out with facility. The opening is generally about two and one-half centimeters in diameter; the upper part is usually loosely woven and serves to conceal the opening.

The male helps the female build the nest which is made of dried leaves and arrow heads of grasses, among which were found: *Imperata cylindrica* (Linn.) Beauv.; *Panicum flavidum* Retz.; *Paspalum conjugatum* Berg.; *Digitaria corymbosa* (Roxb.) Merr.; *Panicum repens* Linn.; *Cynodon dactylon* (Linn.) Pers. The bottom or rather the side opposite the entrance is made first. When the nest is built against twigs, the leaves are first fastened together, then the construction is carried on around to the other end where an opening is provided. The inner surface of the nest is made of dried arrow heads, hence, is smooth, making a comfortable bed for the young.

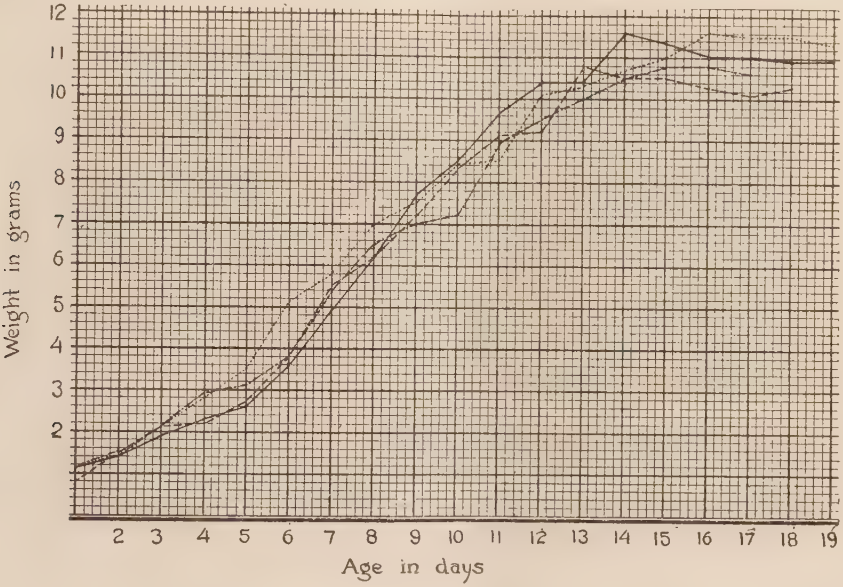

Chart 2.—Showing rate of growth by weight of four nestlings from nest 2

Five to eight eggs are laid in the nest. The egg is oval and measures 16 millimeters (greatest length) by 11 millimeters (greatest diameter). The color is white or pale ochraceous-salmon or intermediate between the two. From one to three of the eggs in a given batch was observed to fail to hatch. In the present investigations it was noted that the eggs hatched in succession at one-day intervals.

Daily observations on the external changes of the young

The writer had in the beginning many nests under observation, but only three can now be considered, because in most cases the eggs and the young were lost, and in a few instances the eggs or the young all died before completing the period of observation. These three nests each contained six eggs, of which, in all cases, only four hatched. The young were weighed daily on a Harvard trip balance. The weights are reported in table 1. During the process of weighing, records were kept of external changes observable in the bodies of the nestlings. The descriptions are given in table 2.

The nestling stage of the weaver certainly extended way beyond the period of eight days covered by table 2, as will be shown presently. However, marked changes in body characteristics occurred only during this period; beyond it no further markedly observable variations were noted, except in gradual enlargement of body parts and further development of the feathers with the accompanying turn of color from brown to chestnut.

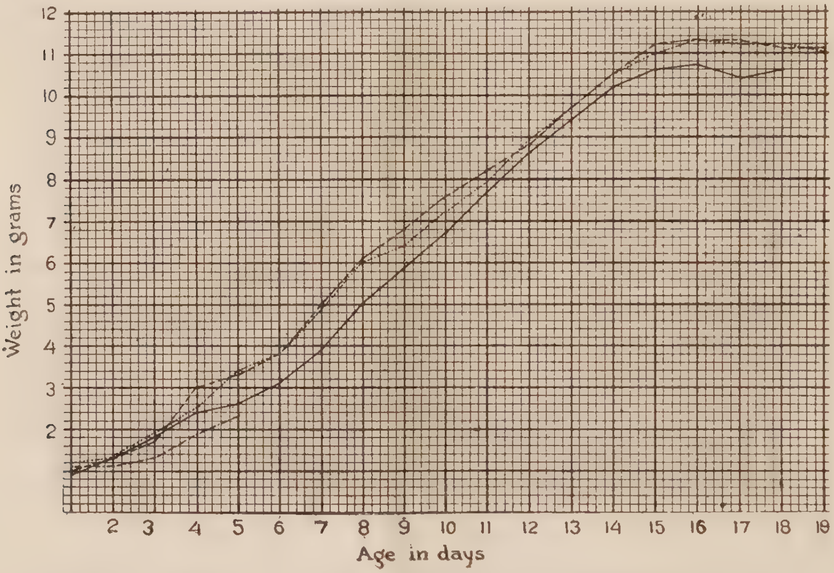

Chart 3.—Showing rate of growth by weight of three nestlings from nest 3.

All nestlings observed flew away the nineteenth day after hatching, except No. 2 of nest 2 and No. 1 of nest 3, which flew on the eighteenth day, and No. 4 of nest 2 which flew on the seventeenth day.

It may be seen from table 1 and by comparing charts 1 to 4 that the growth curves of the young in the three nests ran almost the same course. It should be noted that young No. 4 in nests 1 and 4, which were apparently subnormal, were not considered in computing the average daily weights of the young in their respective nests. Inasmuch as the majority of the young that were weighed flew on the nineteenth day, all those that flew before that length of time, except in the second nest, were not taken into consideration when the average daily weight of the young in the nests was calculated.

To have done otherwise would have made a great deviation from the course which represents the weight of the nestlings that remained until the nineteenth day. This will be very noticeable on the date following the death of No. 4 in nest 1 and Nos. 1 and 4 in nest 3. In nest 2, however, inasmuch as all the nestlings remained until the seventeenth day, only two days less than nineteen, the average daily weight of all the nestlings was computed up to the seventeenth day. It should be understood that there is no appreciable difference between the averages of the first and the second or the second and the third nests. The decline in weight of the young before they flew was presumably due to increased muscular activity in their constant attempts to use their wings.

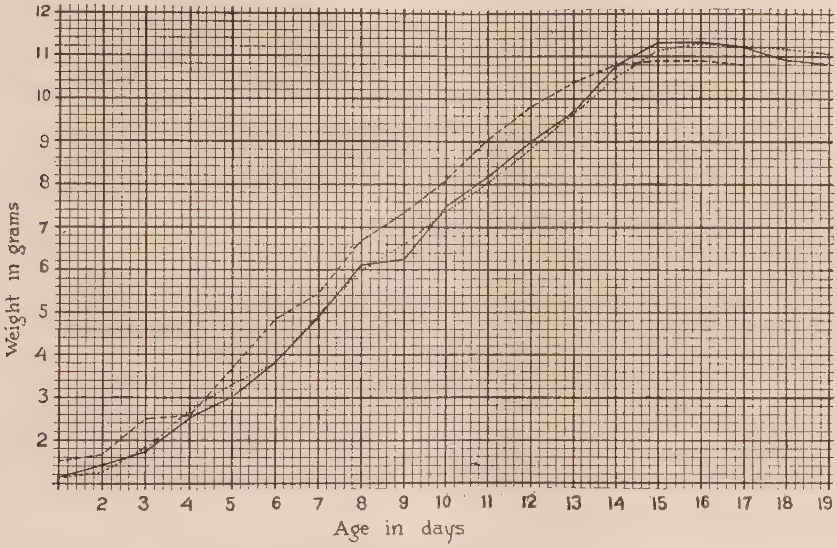

Chart 4.—Showing average rate of growth by weight of nestlings from the three nests observed.

ASSOCIATIONAL HABITS

Gregariousness is an instinctive characteristic of the family Ploceidae. As has been stated in this paper there is a tendency to group themselves even in building their nests.

The Philippine weavers were seen in flocks of hundreds on and near rice fields. In other places, they were seen in association with both *Munia cabanisi* Sharpe and *Passer montanus* (Linnaeus). The bird was seen in more instances with its congener than with *P. montanus.* The two species of *Munia* were observed together on the wing, while feeding, and while at rest. They were noted to alight on the ground where *Paspalum* spp., *Panicum* spp., *Andropogon aciculatus* Retz, and other grasses were in head. When alighting, however, they were observed to group themselves and form a company distinct from *M. cabanisi*. Nests of *M. cabanisi* and *M. jagori* were found on the same tree on several occasions.

At the beginning of the breeding season pairs of sexually mature birds very often separated from the flock. These pairs evidently hunted places where they could build their nests. While they were constructing the nest they fed mostly upon weed seeds that were available and did not take time to go to distant rice fields. Oftentimes, however, the nest builders were seen returning to the flock in the afternoon. The male stayed with the female until all the eggs were laid. Then the female was left alone in the nest going out with the flock only at intervals. The male paid occasional visits to the female while she was sitting on the eggs.

It was observed that a smaller flock would join a larger flock whether it was flying or on the ground. Even if a flock was flying at high speed, the birds alighted at once upon seeing another flock on the ground, or those on the ground would fly up and join the flock in the air.

The flocks were active on the wing in the morning and in the afternoon. In the morning they began coming out at dawn and returned to their resting places at about nine o'clock. Then they came out the afternoon at about four o'clock and returned at sunset.

Flocks of *M. jagori* were observed to rest and to roost in the same place, usually amidst thick patches of *Saccharum spontaneum* var. *indicum* and *Typha capensis*, especially when these were located in secluded places.

SUMMARY

1. The male of *M. jagori* can be roughly distinguished from the female by the color of the head, the male being blackish brown and the female, clove brown. During the breeding season the female can be distinguished by the markedly swollen vent.

2. Copulation presumably took place when the birds were at rest.

3. The nesting season was found to be from the latter part of March to the early part of October. The height of the breeding season is from the beginning of the rainy season in May, to the early part of August.

4. The nest is subglobular and is placed horizontal to the ground level. The opening is at one end of its long axis. Grasses of various species were used in nest building.

5. Nests were observed on five families of plants represented by about fifteen species.[3]

6. Five to eight eggs were laid in one nest. One to three of these usually failed to hatch. The eggs were hatched in succession at one-day intervals.

7. The nestlings generally left the nest nineteen days after hatching.

8. The weight of the nestlings declined the last three or four days before leaving the nest, presumably because of increased muscular activity.

9. The Philippine weaver is decidedly gregarious. It was observed to associate with *M. cabanisi* Sharpe and to a lesser extent with *Passer montanus* (Linn.).

10. During the breeding season pairs of the weaver bird left the flock to find places for their nests.

11. The male and the female were found to coöperate in making the nest.

12. The birds ate weed seed when building nests far from the rice fields.

13. The smaller flock joined the larger.

14. Flocks were found to be active on the wing early in the morning and late in the afternoon.

15. *M. jagori* was found to rest and to roost in the same place, usually in patches of *Saccharum spontaneum* var. *indicum* and *Typha capensis* growing together, far from houses.

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TABLE 1

Daily weights of nestlings[a]

NEST	SPECIMEN NO.	DATE HATCHED	1ST DAY	2ND DAY	3RD DAY	4TH DAY	5TH DAY	6TH DAY	7TH DAY	8TH DAY	9TH DAY	10TH DAY	11TH DAY	12TH DAY	13TH DAY	14TH DAY	15TH DAY	16TH DAY	17TH DAY	18TH DAY	19TH DAY
		1927	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*
1	1	July 13	1.20	1.20	1.30	2.20	2.40	3.60	4.20	5.50	6.50	7.10	8.30	9.30	9.70	10.80	10.90	10.50	10.50	10.30	10.40
	2	July 14	1.10	1.20	2.00	2.20	3.10	3.70	4.80	6.30	6.60	7.50	8.00	8.80	9.50	11.00	11.30	11.50	11.30	11.00	11.00
	3	July 15	1.00	1.70	1.70	3.00	3.40	4.20	5.80	6.50	6.80	7.80	8.30	8.90	9.90	10.70	11.60	11.90	11.90	11.40	11.00
	4	July 16	1.40	1.40	2.20	2.20	2.85	4.00	4.80	(*b*)											
2	1	July 25	1.10	1.40	1.90	2.30	2.60	3.60	4.90	6.20	7.70	8.50	9.70	10.40	10.40	11.60	11.30	11.00	11.00	10.90	10.90
	2	July 26	0.80	1.50	2.10	2.20	2.70	3.80	5.50	6.20	7.20	8.30	9.10	9.20	10.80	10.50	10.50	10.30	10.10	10.30	
	3	July 27	1.20	1.40	2.10	2.80	3.50	5.10	5.80	7.00	7.50	8.40	8.50	10.10	10.30	10.70	11.00	11.60	11.50	11.50	11.30
	4	July 28	1.10	1.50	2.10	2.90	3.10	3.80	5.40	6.50	7.00	7.20	8.90	9.50	10.00	10.50	10.80	10.80	10.60		
3	1	Aug. 9	0.90	1.30	1.80	2.40	2.60	3.10	3.90	5.00	5.90	6.70	7.70	8.60	9.40	10.20	10.60	10.70	10.40	10.60	
	2	Aug. 10	1.00	1.30	1.70	3.00	3.30	3.80	5.00	6.10	6.80	7.60	8.20	8.80	9.70	10.50	11.20	11.30	11.30	11.10	11.10
	3	Aug. 11	1.20	1.30	1.90	2.50	3.40	3.80	4.90	6.00	6.40	7.20	7.90	8.90	9.70	10.50	11.00	11.30	11.20	11.20	11.00
	4	Aug. 12	1.10	1.10	1.30	1.90	2.30	(*b*)													

[a] Weighing was begun on date of hatching.

[b] Bird died and weighing was discontinued.

TABLE 2

Superficially observable changes in weaver nestlings

AGE	EYES	VOICE	CROP	PTERYLA	HAIR FEATHERS	CONTOUR FEATHERS
days						
1	closed	none	spindle-shaped, located ventrally posterior to head	not noticeable	four to six between shoulder girdles	none
2	“	“	moved latero-dorsally in posterior direction	“ “	number increased considerably	“
3	“	“	“ “ “	“ “	increase continued extending to upper arm	“
4	“	“	located dorso-laterally anterior to the junction of shoulder girdle	dorsal and two ventrolateral	increase continued dorsally	“
5	“	“	“ “ “	follicles in evidence	another set at base of pygostyle	eruption of primary feather follicles
6	“	“	“ “ “	eruption of feathers in tracts	generally distributed over body	eruption of secondary feather follicles
7	“	audible	“ “ “	very distinct	“ “	growth of primaries and secondaries continued
8	opened	“	“ “ “	growth of feathers continued	“ “	“ “

ON A ONE-YEAR ROTATION OF TOBACCO WITH CORN AND MUNGO[1]

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Of the Department of Agronomy

WITH TWO CHARTS

Crop rotation is a method of insuring the farmer's income in case of failure in other crops because of the pests and diseases and storms which prevail in this country. The importance of crop rotation is not fully realized by the majority of Philippine farmers. Those who do practice rotation are for the most part interested only in those crops which will give them immediate returns; they neglect altogether the crop which will add fertility to the soil.

In the Cagayan Valley the common practice among the tobacco farmers is to rotate corn with tobacco. In this particular region this practice may be faulty but there is not much danger of exhausting the fertility of the soil because of the overflowing of the Cagayan River which occurs almost every year and which makes the soil very rich. But in regions where such a fortunate condition is wanting, soil management for soil fertility becomes an important factor in successful farming. Green manuring, being within the reach of every farmer, seems the best way of maintaining soil fertility. Besides enriching the soil, it aids in checking the growth of certain pests and diseases.

As is well known, tobacco is a plant which is very exacting in its soil requirements. Given a suitable climate the quality of tobacco produced depends largely upon the mechanical and physical conditions of the soil. Where heavy soil is used for tobacco, the product as a rule is of inferior quality. Light soil containing a large percentage of organic matter is the most suitable for tobacco. No doubt the mechanical and physical conditions of the soil can be improved to some extent by green manuring.

The soil in Los Baños is not adapted to growing tobacco, except in newly opened land or *caingin*, so that growing tobacco as the sole crop would probably not pay. However, corn is grown in this locality and as the land is idle after the corn crop is gathered, tobacco can be planted on it. One of the reasons which led to the investigation which forms the subject of this paper was to find out whether in point of time and season it is possible to rotate tobacco with corn and with a legume. Another reason was to work

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[1] Experiment Station contribution No. 688. Received for publication August 19, 1930. Read in part before the Los Baños Biological Club, January 28, 1929.

out a plan of rotation which might be recommended for other regions where tobacco is one of the crops.

This investigation was conducted for a period of two years, 1927-29, in the Department of Agronomy, College of Agriculture, Los Baños.

MATERIALS AND METHODS

The fields used in this experiment were the old tobacco fields located near the Tobacco House. They were labelled A and B. Systems of crop rotation involving three crops were tried on both fields. In field A, corn (*Zea mays* Linn.) was planted after tobacco, and mungo (*Phaseolus aureus* Roxb.) followed the corn. (See chart 1.) In field B mungo was planted after tobacco; this was followed by corn. (See chart 2.)

Corn was used because there is always a demand for it in Los Baños and also because it is grown in the Cagayan Valley where much of the Philippine tobacco is produced. Mungo was selected for the green manure owing to its adaptability to a wide range of conditions and because it is easy to obtain seed of this legume at any time.

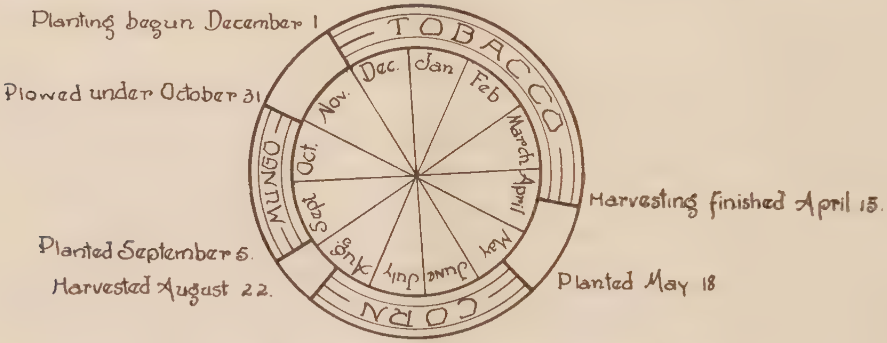

Chart 1.—Showing the system of rotation followed in field A.

This experiment was begun after the tobacco crop of 1927 was harvested. After this harvest, about the middle of April, the two fields were thoroughly prepared. In field A corn was planted on May 18; the crop was gathered on August 22. This crop was in the field for about 95 days from the time of planting to harvesting. The field was prepared as usual for planting. On September 5 mungo was sown in the field at the rate of 30 liters to the hectare. On October 31, when the crop was about eight weeks old it was plowed under with the reversible plow. The planting season for tobacco in Los Baños is December so there was ample time after plowing under the mungo to prepare the land for the planting of tobacco for the following year. The size of this field is less than one-sixth of a hectare. From this field 8 cavans (468 kilograms) of corn grain were harvested.

After preparing the land in field B, mungo was planted on May 23 and was plowed under on July 23, making the legume exactly two months old. It should have been turned under about 10 or 14 days earlier, but owing to unavoidable circumstances this could not be done. The period between plowing under of mungo and planting of corn was sufficient to prepare the land thoroughly. On August 25 the corn was planted. The corn was gathered in the first week of November, a season when the demand for green corn was taken advantage of. The corn was sold at ₱1.00 per hundred ears. The size of this field is about one-fourth of a hectare.

In the following year, 1929, the same system of rotation was tried for the second time and results similar to the first year were obtained.

DISCUSSION OF RESULTS

In the previous years the Cagayan Valley plan had been followed in field A, that is planting corn after tobacco. In field B cowpea (*Vigna sinensis* Savi) had been planted as green manure after tobacco. As to the general stand of the crop, the tobacco crop in field B had always been better than in field A. The question is, did the increase in yield compensate for the expense of green manuring? In the present work no determination on this point was made. However, Hernandez (1919)[2] in his investigation on the effect of natural fertilizers on the production of tobacco found that legume vines gave the highest yield, and improved the burning quality of the leaves. According to his estimate as a result of green manuring there was a gain in production of ₱105 per hectare over the control.

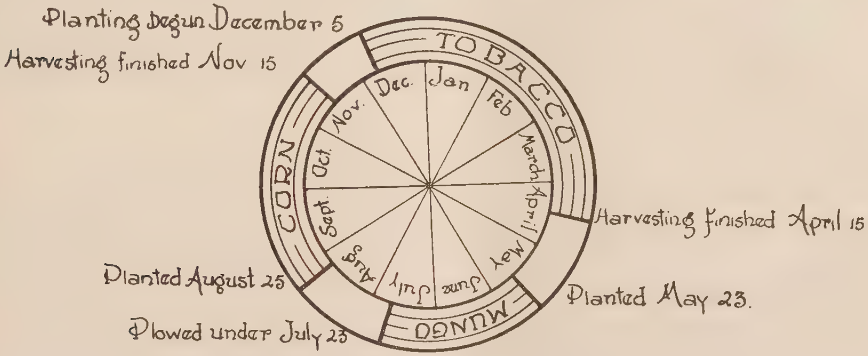

Chart 2.—Showing the system of rotation followed in field B.

Just which of the two systems of rotation in the present work will give the better yield of tobacco crop or the greater profit can be determined only after a few more years of trial. Meanwhile both systems can be recommended under Los Baños conditions in so far as the time required for maturity of each crop and the seasons are concerned. It should be mentioned, however, that there is still a wide field for improvement in these two systems.

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[2] Hernandez, Nemesio M. 1919. The effects of natural fertilizers on the production of tobacco. The Philippine Agriculturist 7: 308–313.

For instance the mungo in both cases should have been turned under at the flowering stage or at the age of from six to seven weeks. In general, the system followed in field A, that is, a one-year rotation of tobacco, corn, and mungo seems to be the better of the two. In the first place the planting of corn almost coincides with the proper planting time in Los Baños.

According to Tiglao (1928)[3], in his investigation on the relation of rainfall to the production of corn conducted at the Experiment Station grounds, there was a better yield in May and in June plantings than in those of other months, because there was optimum amount of rain at the different stages of the plants. He claims that in the July and August plantings too much rain caused the rotting of the seeds and stunted the development of the seedlings. No fixed rule can be formulated as to the definite time of planting because this depends altogether upon the weather conditions in the locality. For example in 1929 there were instances when the preparation of the fields were delayed because of continuous rain which occurred in the locality, which made the soil too wet to be worked. However, a difference of one week or a little longer from the time given in the charts would probably not alter the rotations.

SUMMARY

The result of this investigation may be briefly summarized as follows:

1. In point of time and season of planting, under local conditions, it is possible to practice a one-year rotation with tobacco, corn, and mungo, using tobacco as the major crop.

2. Observation shows that mungo is a convenient cover crop to use. In the first place it matures in a much shorter period than many other legumes and in the second place it thrives under a wide range of conditions.

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[3] Tiglao, Simplicio. 1929. The relation of rainfall to the production of corn. (Abstract by Severino L. Salvado.) The Philippine Agriculturist **17**: 466.

STUDIES ON THE INFLUENCE OF FREE CHOICE OF FEED IN POULTRY FEEDING[1]

VALENTIN G. AMON

WITH TWO TEXT FIGURES AND FOUR CHARTS

INTRODUCTION

The feeding of poultry is the most important problem of a poultry raiser; for it has been found that about 60 per cent of the cost of production of eggs can be traced to feeds (Fronda and Paje, 1930). And in the raising of chicks, this cost represents 41.18 per cent (Paje, 1927). It is obvious then that the feeding of both layers and growing chicks should be given careful consideration, and the work attended to with all possible care if maximum profits are to be realized.

Review of literature

Rugg (1925) conducted experiments on the free-choice of feed in feeding poultry and reported that the birds which had their food before them continuously throughout the twelve months, produced the largest number of eggs and showed the highest profit per bird. The greatest gains were made during April, May, June, and July which are the winter months in Australia. This writer concludes that the pullets at the time they started to lay eggs consumed more feed when they had free access to it than when fed at stated periods. In another experiment Rugg concluded that White Leghorns can be trusted to balance their own ration and that they produced eggs economically.

Paje (1927) found that the amount of feeds needed to raise 100 pullets to 24 weeks of age was 264.00 kgm. of grain, 269.69 kgm. of mash, and 96 incubator eggs. It cost about fifty-four centavos (₱0.54) a bird to raise pullets and cockerels to the age of 12 weeks. The value of twelve-week old cockerels raised from every 100 chicks was found to be ₱18.88; of twenty-four-week-old pullets, ₱77.98.

Sison (1928) found that normally fed chicks, receiving grain and mash, grew faster and were more vigorous than those receiving mash only. Also, the chicks given the normal feeds consumed a little more food than the all-mash fed chicks.

Crucillo (1925), in his experiments on the effect of various amounts of copra meal as supplement in rations for laying eggs, reported that the average feed consumption per bird per year was approximately 29 kgm. He also observed that the feeding of copra meal in amounts varying from twenty to thirty per cent was more profitable than when no copra meal was fed. But when copra meal was given in proportion greater than thirty per cent it proved not profitable. Fronda and Paje (1930) observed that about 28.5 kgm. were required to feed a laying Cantonese hen for one year.

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[1] Thesis presented for graduation, 1930, with the degree of Bachelor of Agriculture from the College of Agriculture No. 322; Experiment Station contribution No. 689. Prepared in the Department of Animal Husbandry under the direction of Dr. F. M. Fronda.

Halpin, Johnson, and Hayes (1916) emphasized the value of mash feed because it is more rapidly digested than the whole or cracked grain. They strongly recommended the feeding of eggs; they gave one egg to every thirty chicks and claimed that it helped greatly in preventing leg weakness.

Objects of the experiment

The object of this experiment was to study the effects of free-choice feeding on the growth and egg production of poultry.

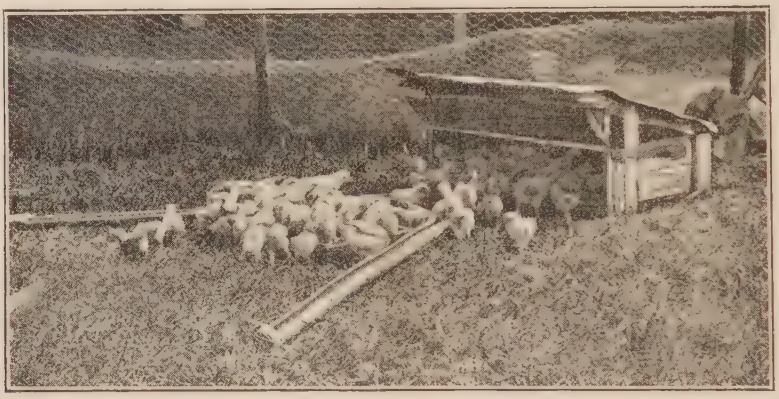

Fig. 1.—The fireless brooder used for brooding the chicks.

Time and place

The experiment was conducted in the Poultry Division, Department of Animal Husbandry, College of Agriculture, Laguna. The experiment which deals with laying pullets was conducted from September 1, 1928, to August 31, 1929, covering a period of exactly one year. The experiment with chicks was run for twenty-four weeks, from June 29, 1929, to December 16, 1929.

MATERIALS AND METHODS

Plan of the experiment

Three methods of feeding were used in this experiment; namely,

a. Free-choice, ingredients in separate receptacles.

b. Grain and mash, but with the proportion of grain to mash optional to the birds.

c. Normal feeding, grain and mash 1:1.

The birds were divided into three lots. The free-choice-fed birds constituted lot I; those under grain and mash feeding but with the proportion of the grain to the mash optional to birds were placed in lot II; and the normal-fed birds which were hand fed, allowing one part by weight of grain to one of mash were in lot III (the control).

All the birds in this experiment received exactly the same attention and care and were raised under conditions as identical as it was possible to procure; the only difference in conditions was in the methods of feeding of birds in the different lots.

Feeding, care, and management

Two hundred and fifty-five Cantonese chicks (one-day old) were used in this part of the experiment. They were divided into three lots of eighty-five chicks each. They were legbanded and placed in three different compartments. On the second day after hatching they were given the different feeds, all the ingredients being finely ground. They were fed five times daily. For every thirty chicks one egg a day was allowed.

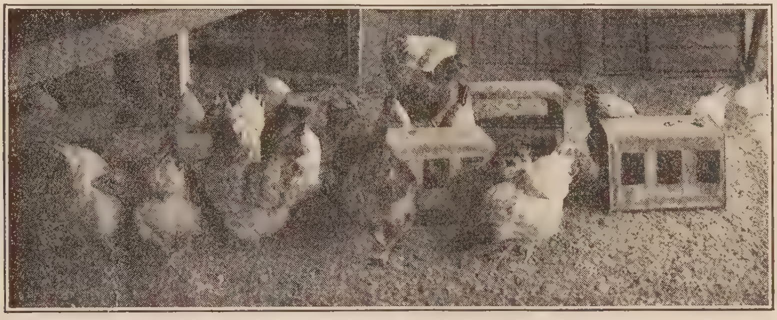

Fig. 2.—Feeding troughs used for the different ingredients of feed in lots I and II.

Seventy-five Cantonese pullets were used in the study with layers. These were apparently of the same quality and were divided into three lots, I, II, and III, twenty-five birds to each lot. These pullets were treated in the same manner as the chicks.

The chicks in lot I (free-choice) were given as much as they could eat of five kinds of feeds. These feeds were: corn meal, ground palay, copra meal, rice bran, ground shrimps. The chicks in lot II were given grain and mash; the proportion of the grain to the mash was optional to the birds. These chicks were fed also at will. Lot III, (hand fed), was the control. In this lot, grain was fed once in the morning and once in the afternoon. The birds had free access to dry mash during the day and wet mash was given at noon. All feeds in all the lots were served in bamboo troughs at first. Later, tin cans were provided. Drinking water was accessible at all times. The second month, the composition of feeds in lot I was varied by adding ground cracked corn, as the chicks were then large enough to eat it. The same method of feeding was followed till the end of the experiment, or till the birds were twenty-four weeks old.

Eggs were fed to the chicks only the first two weeks. The eggs were boiled hard and chopped into fine pieces and in lot II mixed with the mash, moistening it with water. In lot I the chopped boiled eggs were mixed with the corn meal. The grain was a mixture of equal parts of cracked corn and palay. As the chicks were confined in separate compartments inside the laboratory for four weeks they were given every day chopped green feed gathered from wild growth in the vicinity.

The feeds were prepared weekly in varied amounts according to the age of the birds. The mash which was used in both lot II and lot III was a mixture of one part dried shrimps, two parts corn meal, three parts copra meal, four parts rice bran and a sufficient amount of common salt was added to make one per cent of the total mixture.

The grain mixture remained the same throughout the experiment, except that a mixture of cracked corn and whole palay was given when the birds were large enough to eat these grains. Beginning with the twentieth week the grain was fed whole.

When the chicks were taken from the laboratory to the yards they were given free access to green grass on the range. During the brooding period the chicks in each lot were reared in separate fireless brooders made of boxes and old galvanized iron (see fig. 1.) Galvanized iron and shade trees were used to protect the birds from heavy rain and enemies, especially the hawks. The brooders were provided with excelsior bedding which was changed three times a week.

When the chicks were young the grain fed was ground. In the experiment with laying pullets no grain was ground although the ingredients used were the same as those given to the chicks. The feeds were served in kerosene can troughs (see fig. 2). The chicks were housed in three separate pens in the laying houses. There were yards adjoining the pens where the birds could exercise and eat green feed.

Records

The chicks were weighed weekly for a period of twelve weeks from the first day of the experiment till they were weaned (at twelve weeks of age). The cockerels were then discarded and the pullets retained. The pullets were weighed weekly and the layers, monthly. The different amounts of feeds consumed a week by chicks and pullets and the different amounts consumed a month by the layers were carefully recorded. The record of the number of eggs laid was also kept. The length of the time to maturity of the growing pullets was carefully observed. The general condition of the birds was noted. Mortality records were also kept.

Prices of feeds

The local market prices of feeds used upon which computation was based were as follows:

	Price per kgm.
Corn	₱0.083
Palay	0.092
Rice bran	0.072
Copra meal	0.077
Dried shrimps	0.214
Corn meal	0.112
Common salt	0.014

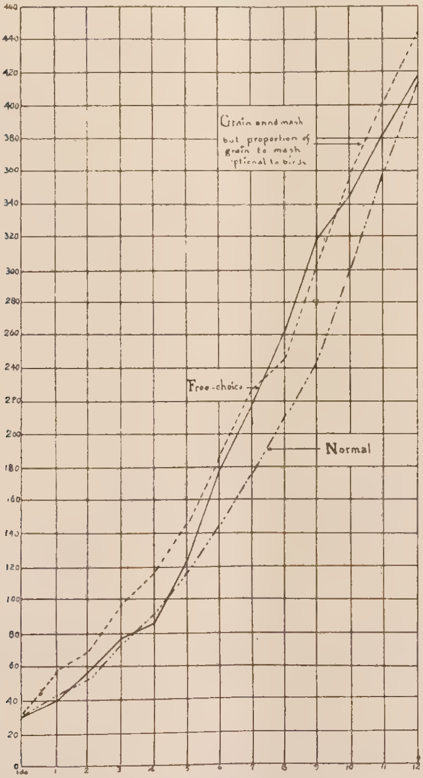

Chart 1.—Weight curves of Cantonese chicks in the free-choice, grain, and mash, but proportion of grain and mash optional to birds and in normal lots.

RESULTS AND DISCUSSION OF RESULTS

Chicks to twenty-four weeks

Growth of chicks. The weight of the chicks at different periods was used as the criterion in determining their comparative growth in this experiment. These are given in table 1. In this table it may be seen that grain and mash feeding in which the proportion of grain to mash was optional to the birds, with the exception of the eighth and ninth weeks, resulted in consistent gain in weight in its favor when compared with gains of chicks in the free-choice lot and the normal lot. The differences in growth between lots II and I, and II and III are not great, however. No appreciable difference can be observed in the rate of growth of chicks in lots I and III from the beginning of the experiment to the twelfth week. Chart 1 shows graphically the difference in the rate of growth. This graph shows clearly the slight superiority of the grain and mash feeding in which the proportion of grain to mash was optional to birds (lot II) over the free-choice (lot I) as well as the control (lot III), except in the eighth and ninth weeks in which the growth of lot I birds was slightly greater than those in lot II.

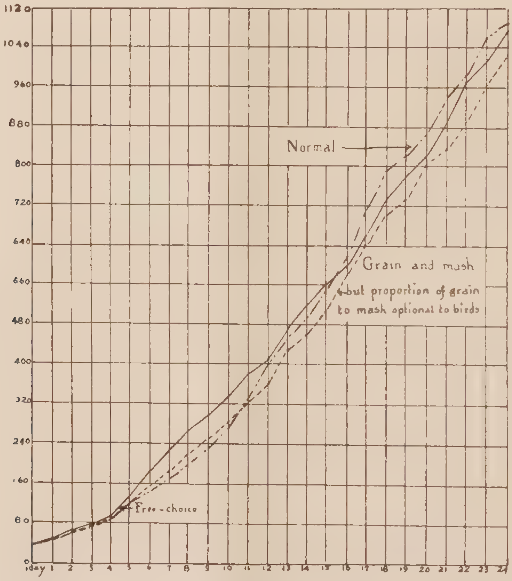

Chart 2.—Curves showing the comparison of the rate of growth of female chicks raised to twenty-four weeks.

Growth of pullets in the first twenty-four weeks. Table 2 shows the comparison of the rate of growth of all pullets in the first twenty-four weeks in all the three lots studied. This table shows that the average weights of the birds from the beginning up to the age of twelve weeks decreased when the male birds were excluded from the computation. The female birds in lot I show a slightly better rate of growth than the other two lots from the time they were baby chicks till the weaning age (12 weeks). This rate seems to be in contrast to the computed average weights of chicks when the females and males were mixed. It may be seen, however, that there is no appreciable difference between the rate of growth of the female birds in lot II and lot III. The average weights of the birds during the twelfth week or the time when they had become weanlings were 404.3 grams in lot I, 373.5 grams in lot II, and 394.1 grams in lot III. It may be seen from the table that the pullets in lot III made a slightly better rate of growth than the pullets of lots I and II. There is, however, no marked difference between the average final weights of the pullets at the age of twenty-four weeks. These weights are 1085.0 grams in lot I, 1029.3 grams in lot II, and 1087.7 grams in lot III. Chart 2 shows the comparative rates of growth of the chicks raised to twenty-four weeks old.

On account of the difference in the number of birds to each lot; namely, thirty for lot I, forty for lot II, and thirty for lot III, it was thought that comparison might not be justifiable. The idea was suggested that the standard deviations might help in determining whether or not the birds in lot II suffered as a result of over-crowding. When this was done it was found that over-crowding did not enter as a factor in this experiment; in fact, it appeared that the birds in lot II varied less than those in lot I, as expressed by the coefficient of variability which was found to be 20.35 per cent for lot I, 17.58 per cent for lot II, and 13.55 per cent for lot III.

Amount of feeds consumed

Free-choice. Table 3 shows the relative amounts of the different ingredients of feeds consumed at different ages. During the first four weeks the only grain used was palay, and the mash was composed of corn meal, copra meal, rice bran, and dried shrimps fed in separate containers. It may be noted in this table that the least individual consumption of feed up to end of the twenty-fourth week is under the copra meal column. It is quite probable that copra meal is not palatable when fed alone. There is a little difference in the consumption of corn meal and rice bran. The total grains consumed to the end of the twelfth week were 62.80 kgm. of corn and 54 kgm. of palay; the total mash consumed was 21.80 kgm. of corn meal and 8.60 kgm. of copra meal; and there was a total of 20.60 kgm. of rice bran and 17.80 kgm. of shrimps (not shown in table). These amounts of the different ingredients consumed, however, were sufficient apparently to supply the necessary nutrients for the growth of the young birds, since their rate of growth up to this period could compare very favorably with that of the normal-fed birds in lot III. The differences in the amounts of the individual consumption of the ingredients of grain and mash was probably due, in part, to a difference in palatability of the different kinds of the feeds used. The rate of consumption of the different ingredients remained practically the same from the twelfth week to the end of the experiment. According to these results, corn is more palatable than palay, which is contrary to the findings of Tuason and Fronda (1923) who reported rough rice or palay to be more palatable than corn when sorghum was counted as one of the ingredients of the grain. In comparing the palatability of corn meal, rice bran, and shrimps very little difference can be observed. The table shows that corn meal is the most palatable of all the ground feeds, rice bran second, shrimps, third, and copra meal, least. It is clear that the consumption of feeds increased as the chicks became older.

Table 4 shows the relative proportion of the different ingredients of the grains, the ingredients of the mash and the proportion of grain to mash computed in four-week periods. It may be seen from this table that during the first four weeks the chicks consumed all the palay given them, owing to the fact that it was the only constituent of the grain feed given. Among the ingredients of the mash consumed in this period it was found that corn meal was the best liked, shrimps next, rice bran next, and copra meal the least, reaching only 9.7 per cent. The percentage of grain to mash consumed at this time was about one part of grain to two parts of mash. This result was due to the absence of corn in the grain and the presence of corn meal in the mash which made the percentage of the mash higher than the grain. There was no appreciable difference between the percentages of corn consumed in the other four-week periods that followed. The same uniformity in percentages of palay consumed was observed. Excluding the first four-week period, the percentages of copra meal consumed varied from 53.1 per cent to 54.0 per cent, and the palay varied from 46.0 per cent to 46.9 per cent. On the other hand the proportions of the ingredients of the mash were more variable as compared with the proportions of the ingredients of the grain. The proportion of the total grain to mash consumed in four weeks was fairly uniform after the first four-week period. After that the consumption of grain ranged from 57.9 per cent to 65.6 per cent, and of mash from 35.2 per cent to 42.1 per cent. The total percentages of the grain consumed was 59.2 per cent and of mash, 40.8 per cent. This result shows that the birds were more grain feeders than mash feeders.

Table 5 shows the amount and proportions of feed consumed at different ages by the birds in lot II. In this table it may be seen again that the grain consumption is slightly greater than the mash. This lot consumed 165.5 kgm. of grain and 136.9 kgm. of mash. The proportion computed in four-week periods is fairly uniform. The percentage of grain in any of the four-week periods, exceeds the percentage of mash by approximately ten per cent, the ratio of the total feed consumed being 54.8:45.2. This result again seems to show that birds prefer to eat more grain than mash

Table 6 shows the amount of feeds consumed at different ages in lot III. The data show that the amount of grain and mash consumed was the same This may be expected as the feed given to the birds was regulated by the poultryman. There was a slight rate of increase of feed consumption as the birds advanced in age. It may be seen also from table 6 that the amount of feed consumed decreased during the thirteenth week. This decrease was due to the removal of the cockerels from the lot, leaving thirty-three female birds out of the sixty-four weanlings. The total feed consumed was 148.30 kgm. of grain and 148.20 kgm. of mash. The computed percentages based on the four-week periods are almost even, in fact the ratio between the total grain and mash is an equality.

Table 7 shows the cost of feeds necessary to produce weanlings. It is seen that the free-choice fed lot, lot I, is more expensive than either the normal in which the proportion of the grain to the mash was optional to the birds, lot II, or the normal fed lot, lot III. The greatest expense among the individual ingredients of lot I was the dried shrimps, ₱4.18, and the least the copra meal, ₱0.35. In lot II the cost of the grain was ₱6.23 and the mash ₱5.75. In lot III the grain cost ₱6.09 and the mash ₱6.20. The total costs of feeds used for the production of weanlings was ₱15.86 for lot I, ₱11.98 for lot II, and ₱12.29 for lot III. The total feed cost computed for every 100 birds weaned was ₱24.03 for lot I, ₱17.36 for lot II, and ₱19.20 for lot III. This shows that the free-choice lot was the most expensive of the three methods of feeding studied.

Table 8 shows the cost of feeds necessary to produce mature pullets from the weanlings. In lot I, corn cost the most and copra meal the least. The total cost of all feeds consumed was ₱18.58. The grain cost ₱8.67 and the mash, ₱7.94 in lot II; in lot III the grain cost ₱7.28 and the mash, ₱8.10. Comparing the total feed expenses it may be seen that it cost ₱18.58 to feed the pullets in lot I, ₱16.61 in lot II, and ₱15.37 in lot III. If these expenses were computed on the basis of 100 birds raised to maturity the total cost of feeds in lot I would be ₱61.93. in lot II, ₱41.52, and in lot III, ₱51.23. This comparative amount of expenses shown in this table is similar to that in table 7, lot I being the most expensive, lot II lower, and lot III the least.

Table 9 shows the costs of birds produced and the cost of feeds consumed. The cost of weanling cockerels and pullets was computed at ₱0.80 per kgm. live weight. At this rate, it was found that the total cost of the birds raised from each lot was:

Lot 1....................	₱37.44
Lot II....................	₱42.64
Lot III..................	₱37.60

Subtracting the feed cost from the cost of the birds produced, the profit would be ₱2.51 in lot I, ₱14.05 in lot II, and ₱9.94 in lot III. The feed cost a pullet raised to 24 weeks old was ₱1.16 in lot I, ₱0.71 in lot II and ₱0.92 in lot III.

The cost of infertile eggs used was not included in the computation of the cost of feeds because in all three lots several pullets started to lay two weeks before the experiment was ended The returns from the sale of the eggs laid by the pullets was more than the cost of the infertile eggs used in each lot. The free-choice system is the most expensive of the three methods of feeding used; also it required more labor, especially in preparing and giving the feeds to the birds.

Table 10 shows the length of maturity of the pullets raised. It may be seen in this table that the pullets in all the different systems of feeding studied matured early and at practically the same time, 161 days for those in lot I, 163 days for those in lot II, and 160 days for those in lot III. The system of feeding employed apparently had no influence upon the rate of maturing of the pullets. The percentage of pullets laying at the age of twenty-four weeks was the same in both lot I and lot II. The percentage of the pullets laying at the end of the twenty-four weeks was 16.7 for lot I, 10.00 for lot II, and 16.7 for lot III.

The total number of eggs produced was 49 in lot I, 29 in lot II, and 47 in lot III. All the eggs were valued at ₱0.04 each and the amount realized for lot I was ₱1.96, for lot III, ₱1.16, and for lot II, ₱1.88. For every 100 pullets raised to twenty-four weeks of age the value of eggs that may be expected is ₱6.52 in lot I, ₱2.88 in lot II. and ₱6.28 in lot III. The value of eggs produced before the expiration of the experiment as shown by the results from all the lots more than covered the incidental expenses incurred in the running of the experiment.

Mortality

Table 11 shows a comparison of mortality in the three lots computed on the basis of four-week periods. During the first four weeks the mortality of the chicks was greater in the normal lot than in the other two lots. During this period only 2 chicks died in lot I, 3, in lot II, and 7, in lot III, the check lot. These results seem to show that the system of feeding used in lots I and II was not harmful to the chicks. During the succeeding four-week period, the mortality in the three lots was practically the same. The table shows a marked increase of mortality during the third four-week period because of accidents. That period occurred at the time when typhoons and heavy rains were prevalent and a number of birds died from chilling. This accounts for the high percentages of mortality in all of the lots. During the pullet stage, very few birds died.

Layers

Weight. Table 12 shows the average of the weights of the layers taken every month during the period of one year. It should be noted that the average weights of the 25 birds in each lot at the beginning of the work in September were comparatively low; the reason for this is that some of the birds were not quite fully matured. The birds used in these experiments were selected pullets of the same age. The birds in the free-choice lot, lot I, weighed a little less than the other lots in October because they laid more eggs during this time. From November to August there were no great differences between the average weights of the birds in the three lots. In chart 3, the fluctuations in weight of the layers are shown graphically. An abrupt decrease in the weights of the normal lot during April and May is to be noted. This decrease was probably caused by the greater number of eggs laid by the birds in this lot and by the hot weather prevailing at the time.

Amount and proportions of feed consumed. Table 13 shows the amount of feed consumed by the layers in lot I at different periods. Unlike the system of feeding used in lot I of the experiment in chicks, all the six kinds of ingredients were fed from the start, and carried through a period of one year. The greatest consumption of feed was during the first month when the birds apparently had a good appetite, especially for corn which showed the highest amount of individual feed utilized. In regard to grain it may be seen that more corn than palay was consumed. With the mash, the amount of copra meal consumed was decidedly low as compared with the usual amount used in the ordinary mash preparation of the mixed feed. This result is in conformity with the result obtained in the experiment with chicks. The totals for the yearly consumption of the individual kinds of feeds are 251.0 kgm. corn, 200.9 kgm. palay, 65.1 kgm. corn meal, 24.3 kgm. copra meal, 33.4 kgm. rice bran, and 54.5 kgm. dried shrimps. The total amount of corn meal and shrimps consumed varied slightly, but the corn meal was a little more than the shrimps. The total copra meal consumed was less than one-half of total of either corn meal or shrimps.

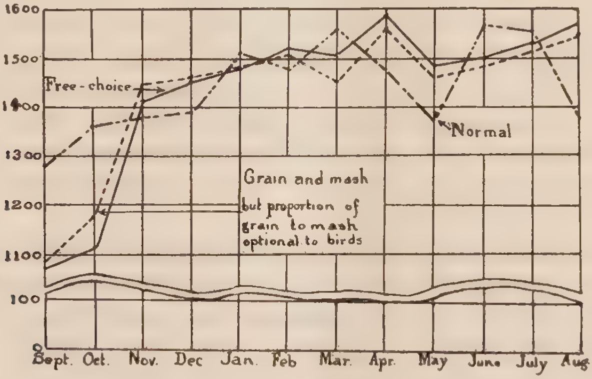

Chart 3.—Curve showing the average weight of layers.

Table 14 shows the amount of feeds consumed expressed in the proportion, or percentages, in lot I (layers) computed in four-month periods. It may be seen from this table that the average percentages of corn, as well as palay, were fairly constant in all the four-month periods. In a slightly less degree this statement holds of the ingredients of the mash. The slight difference in percentage of consumption between corn and palay may be attributed to the fact that the corn is more palatable than the palay. The range of percentages among the ingredients of the mash consumed is highest with the corn meal and lowest with the copra meal. The percentages of dried shrimps consumed closely followed that of the corn meal The proportion of the grain to mash consumed as found in the table clearly shows that the grain is more palatable than the mash when given to the birds separately. The computed percentages based on the total consumption for the year of the ingredients of the grain are 55.5 per cent of corn and 44.5 per cent of palay. The total percentages of the ingredients of the mash consumed are 36.7 per cent corn meal, 13.7 per cent copra meal, 18.8 per cent rice bran, 30.7 per cent shrimps. The proportion of the total grain in mash consumed in one year is 71.8 per cent of grain to 28.2 per cent of mash.

Table 15 shows the amount and proportions of feed consumed by the birds in lot II computed in four-month periods. This table clearly shows the difference between the amount of grain and mash consumption. Out of the total amount of feeds consumed, 449.3 kgm. were grain and only 160.0 kgm. were mash. The relative percentages of grain consumption in the different periods were considerably higher than the relative percentages of mash consumption. The amount of grain consumed is markedly greater than the amount of mash. This again seems to point out that the chicken is a highly voracious grain feeder.

The amount and proportions of feed consumed in twelve months by the birds in lot III are shown in table 16. It may be seen from this table that the amounts of grain and mash consumed are practically the same. The amounts and proportions of grain to mash feed consumed which was controlled by the poultryman made this result different from the results in the other two systems of feeding where the amounts of feed consumed were optional to the birds in both cases. The total amounts of feed consumed were 368.0 kgm. of grain and 363.3 kgm. of mash, giving a proportion of approximately one part of grain to one of mash.

Egg production. The number of eggs produced is given in table 17. As is shown in this table the normal-fed birds (lot III) laid a few more eggs than those which were allowed the free-choice of their feed (lot I). The same is true when either lot is compared with the grain and mash lot, in which the proportion of grain to mash was optional with the birds (lot II). However, the differences between the total number of eggs produced in the three lots were not appreciable. The egg production of lot I increased considerably during the month of October and exceeded that of the other two lots. On the other hand the birds in this lot were lighter so that what was spent for growth in lot II and in lot III was probably used for producing eggs in the case of lot I. During this month the number of eggs produced was 262 in lot I, 170 in lot II, and 209 in lot III. It may be also noted in table 17 that the monthly egg production in lot I was almost uniform, except during the months of September and December when there were fewer eggs laid. Lot II attained its highest monthly egg production in February when there was also a marked increase in the number of eggs laid by the birds of lot III. The greatest number of eggs laid with the corresponding high percentages of production was credited to the birds of lot III, the highest performance being reached during the month of April. The total numbers of eggs produced in twelve months were 2,651 in lot I, 2,704 in lot II and 2,737 in lot III. In chart 4 the fluctuations in egg production of the different lots in percentages are shown graphically. It may be seen that the maximum productions were attained in April for lots I and III, and in February in lot II.

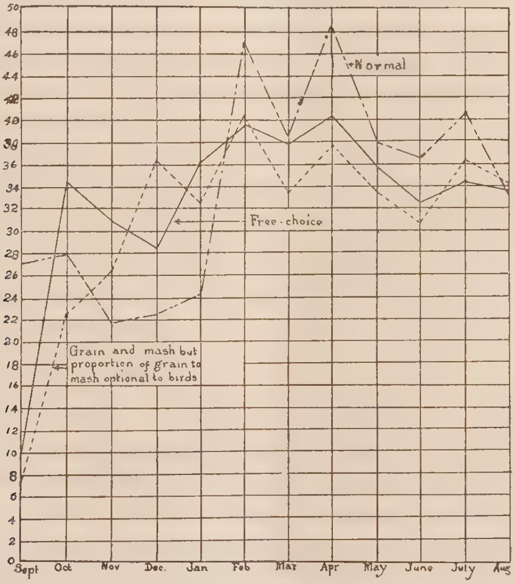

Chart 4.—Curves showing the comparison of the percentages of egg production.

Table 18 shows the cost of feeds consumed by the layers. As is shown in this table the actual cost of feed consumed was greatest in the normal-fed lot, lot III. The reason is, this lot had the highest number of birds at the end of the experiment. The total feed costs were ₱63.01 in lot I, ₱56.44 in lot II, and ₱69.45 in lot III. When computed on the basis of the individual bird left at the end of the experiment the cost of feed is ₱3.00 in lot I, ₱2.50 in lot II, and ₱3.17 in lot III. These results show the advantage on egg production of the grain and mash in which the proportion of the grain to the mash was optional with the birds, as in lot II, over the free-choice as well as the check lot, normal method, where the proportion of the grain to the mash was regulated by the feeder. This may account for the greater total feed cost for 100 birds in lot I than in the other lots. The total feed cost for every 100 birds was ₱286.41 in lot I, ₱242.23 in lot II, and ₱250.31 in lot III.

Table 19 shows the cost of feeds needed for egg production in the different lots. All the eggs produced were valued at five centavos each. The total value of eggs was almost the same in all the lots. The eggs produced in lot I cost ₱132.55, those in lot II, ₱135.20, and those in lot III, ₱136.85. Subtracting the feed cost from the cost of the eggs produced the returns above the cost of feeds from each lot was ₱69.54 in lot I, ₱78.76 in lot II, and ₱67.40 in lot III. Of the different systems used, the greatest profit in value of eggs over cost of feeds consumed was obtained from lot II.

Table 20 shows a comparison of mortality in the different lots studied. Four birds died in lot I, two in lot II, and three in lot III. The percentages of mortality were 16 per cent in lot I, 8 per cent in lot II, and 12 per cent in lot III. One of the birds in lot I, No. 162, died of "hemorrhagic oophoritis and cloacitis" according to the report from the College of Veterinary Science where the bird was subjected to a postmortem examination. Another bird in lot II, No. 177, was killed by an alimos (*Paradoxorus philippinensis* Jourdan) which visited the pen on the night of October 18, 1928. All the other deaths in the lots were caused by egg-bound and eggs broken inside the body. It will be seen that, except in lot I, the mortality among the layers during the year was about normal, which is about 12 per cent a year.

SUMMARY AND CONCLUSIONS

1. The results of studies of the effects of free-choice feeding on the growth and egg production of poultry are reported in this paper.

2. The following methods of free-choice feeding of poultry were compared with the normal feeding (grain and mash 1: 1):

   a. Free-choice, ingredients in separate receptacles.
   b. Grain and mash, but with the proportion of grain and mash optional to the birds.

3. The different methods of feeding did not produce any appreciable difference in the rate of growth of chicks. Also the difference in the average weight of the pullets at the twenty-fourth week of age is not significant.

4. Of the three methods of feeding studied, the free-choice fed birds consumed the most feed. The lot given grain and mash, but with the proportion of grain and mash optional to the birds, consumed the least.

5. There was practically no difference in mortality among the chicks in the different methods of feeding studied.

6. The systems of feeding studied apparently had little or no influence on the rate of maturity of the pullets.

7. The relative percentage of pullets laying at the end of the twenty-fourth week was about the same in all the three methods of feeding studied.

8. The cost of raising 100 pullets to weaning age was highest in the free-choice method. The cost was about the same in the other two methods.

9. To raise 100 pullets from weaning age to the age of twenty-four weeks, it cost ₱61.93 in the free-choice method of feeding, ₱51.23 in the normal and only ₱41.52 in the grain and mash, but with the proportion of grain and mash optional to the birds.

10. Of the three methods of feeding layers studied, the free-choice lot produced the least number of eggs, the other two methods were about the same.

11. The free-choice fed layers consumed twenty-nine kgm. of feed each for a year, the other two lots twenty-seven kgm. each.

12. Of the different systems of feeding used the grain and mash feeding in which the proportion of the grain to the mash was optional with the birds gave the greatest return above the cost of the feeds consumed.

13. It was observed that both the chicks and the layers consumed more grain than mash if they were allowed to choose their feed.

14. Neither the chicks nor the layers relished copra meal.

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TABLE 1

Average weekly weights of Cantonese chicks in the free-choice, grain and mash but with the proportion of grain to mash optional to birds, and normal lots
(June 29, 1929 to September 22, 1929)

AGE	LOT I (FREE-CHOICE)		LOT II GRAIN AND MASH BUT PROPORTION OF GRAIN TO MASH OPTIONAL TO BIRDS		LOT III (NORMAL)	
	Number of chicks	Average weight	Number of chicks	Average weight	Number of chicks	Average weight
		grams		*grams*		*grams*
1 day old	85	30.2	85	30.5	85	30.4
1 week	85	40.4	84	51.1	85	40.2
2 weeks	84	56.1	84	67.3	84	55.0
3 weeks	83	72.3	83	93.2	84	70.5
4 weeks	82	89.6	82	117.3	78	91.0
5 weeks	79	123.3	81	148.9	78	118.9
6 weeks	77	176.0	79	188.2	76	147.8
7 weeks	76	217.2	78	227.0	75	178.4
8 weeks	76	264.0	76	249.8	74	213.7
9 weeks	74	315.8	74	307.0	72	246.0
10 weeks	72	349.5	69	355.5	64	301.2
11 weeks	67	385.5	69	403.7	64	357.8
12 weeks	66	417.5	69	444.4	64	418.2

TABLE 2

Comparison of the rate of growth of female chicks raised to twenty-four weeks (June 29, 1929 to December 16, 1929)

AGE	LOT I		LOT II		LOT III	
	Number of birds[a]	Average weight	Number of birds	Average weight	Number of birds	Average weight
		grams		*grams*		*grams*
1 day old	32	30.9	42	30.2	33	30.0
1 week	32	41.4	42	38.8	33	40.2
2 weeks	32	57.6	42	55.2	33	55.0
3 weeks	32	76.3	42	67.9	33	70.0
4 weeks	32	94.1	42	93.7	33	88.7
5 weeks	32	128.7	42	116.9	33	114.8
6 weeks	32	183.1	42	148.1	33	142.0
7 weeks	32	222.9	42	185.3	33	169.2
8 weeks	32	269.8	42	220.7	33	203.0
9 weeks	32	309.9	42	242.8	33	227.5
10 weeks	32	338.5	42	285.1	33	277.0
11 weeks	32	377.2	42	328.3	33	329.3
12 weeks	32	404.3	42	373.5	33	394.1
13 weeks	32	472.0	42	444.4	33	451.6
14 weeks	31	519.5	41	472.7	30	496.8
15 weeks	31	560.0	41	526.2	30	559.1
16 weeks	31	602.7	41	572.8	30	620.7
17 weeks	30	662.4	40	642.3	30	696.0
18 weeks	30	737.0	40	702.1	30	786.0
19 weeks	30	773.5	40	734.1	30	829.0
20 weeks	30	817.7	40	805.9	30	856.6
21 weeks	30	898.8	40	846.6	30	921.5
22 weeks	30	975.2	40	895.0	30	987.8
23 weeks	30[b]	1019.8	40	960.1	30	1061.3
24 weeks	30	1085.0	40	1029.3	30	1087.7

[a] The birds in this column are considered as chicks up to 12 weeks of age, thereafter they are considered as pullets.

[b] In all of the lots some of the birds began to lay eggs.

TABLE 3

Showing the amount of feeds consumed at different ages in lot I of chicks

WEEKS	TOTAL NUMBER OF BIRDS	GRAIN			MASH					TOTAL FEED
		Corn	Palay	Total	Corn meal	Copra meal	Rice bran	Shrimps	Total	
		kgm.	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*
1	85[a]	——	1.0	1.0	1.0	0.2	0.6	0.6	2.4	3.4
2	84	——	1.6	1.6	1.6	0.4	0.7	1.0	3.7	5.3
3	83	——	2.0	2.0	2.0	0.4	1.0	1.0	4.4	6.4
4	82	——	3.0	3.0	2.5	0.5	1.0	1.0	5.0	8.0
5	79	4.0	3.5	7.5	2.0	0.3	1.5	1.5	5.3	12.8
6	77	4.5	4.0	8.5	2.0	0.2	1.5	1.8	5.5	14.0
7	76	4.6	4.0	8.6	2.0	0.2	1.5	2.0	5.7	14.3
8	76	5.0	4.0	9.0	2.5	0.3	2.0	2.5	7.3	16.3
9	74	5.5	5.0	10.5	3.0	0.5	2.0	2.0	7.5	18.0
10	72	5.6	5.0	10.6	3.0	0.5	2.0	2.0	7.5	18.1
11	67	5.7	5.0	10.7	3.0	0.5	2.0	2.0	7.5	18.2
12	66	5.8	5.0	10.8	3.0	0.5	2.0	2.1	7.6	18.4
13	32[b]	3.0	3.0	6.0	2.0	0.5	2.0	1.5	6.0	12.0
14	32	4.2	4.0	8.2	2.0	0.6	2.0	1.5	6.1	14.3
15	31	5.0	4.0	9.0	2.0	0.6	1.6	1.5	5.7	14.7
16	31	5.0	4.0	9.0	1.8	0.7	1.5	1.6	5.6	14.6
17	31	5.0	4.0	9.0	2.0	0.6	1.8	1.6	6.0	15.0
18	30	5.5	5.0	10.5	1.3	0.9	1.2	1.2	4.6	15.1
19	30	5.6	5.0	10.6	1.5	0.9	1.6	1.0	5.0	15.6
20	30	6.0	5.0	11.0	1.7	1.0	2.0	1.3	6.0	17.0
21	30	5.5	5.0	10.5	1.5	0.8	1.8	1.5	5.6	16.1
22	30	6.0	5.0	11.0	2.0	1.0	2.0	1.5	6.5	17.5
23	30	6.0	5.0	12.0	2.0	0.5	1.1	1.6	5.2	16.2
24	30	6.0	5.0	11.0	2.0	0.5	2.0	2.0	6.5	17.5
Total....	——	103.5	97.1	200.6	49.4	13.1	38.4	37.3	138.2	338.8

[a] Incubator eggs used up to two weeks = 28.

[b] Cockerels removed.

TABLE 4

Amount of feeds consumed expressed in proportions or percentages in lot II of chicks
(June 29, 1929 to December 16, 1929)

PERIOD IN WEEKS	TOTAL NUMBER OF BIRDS	GRAIN			MASH					PERCENTAGE OF GRAIN	PERCENTAGE OF MASH
		Corn	Palay	Total grain	Corn meal	Copra meal	Rice bran	Shrimps	Total mash		
		per cent	*per cent*	*kgm.*	*per cent*	*per cent*	*per cent*	*per cent*	*kgm.*		
1–4	85	0	100	7.6	45.8	9.7	21.3	32.2	15.5	32.9	67.1
5–8	82	53.9	46.1	32.6	35.7	4.2	27.3	32.8	23.8	58.5	41.5
9–12	76	53.1	46.9	42.6	59.9	6.6	26.6	26.9	30.1	58.6	41.4
13–16	32[a]	53.4	46.6	32.2	33.3	10.3	30.3	26.1	23.4	57.9	42.1
17–20	31	53.8	46.2	41.2	30.1	15.7	30.6	23.6	21.6	65.6	34.4
21–24	30	54.0	46.0	43.5	31.6	11.8	29.1	27.8	23.7	64.7	35.2
Total...	—	——	——	200.6	——	——	——	——	183.1	59.2	40.8

[a] Cockerels removed.

TABLE 5

Total amount and proportion of feed consumed at different ages in lot II of chicks (June 29, 1929 to December 16, 1929)

NUMBER OF WEEKS	TOTAL NUMBER OF BIRDS	TOTAL CONSUMPTION			PERCENTAGES[c]	
		Grain	Mash	Total	Grain	Mash
		kgm.	*kgm.*	*kgm.*	*per cent*	*per cent*
1	84[a]	2.0	1.6	3.6	——	——
2	84[a]	2.5	1.7	5.2	——	——
3	83	3.5	3.0	6.5	——	——
4	82	4.5	4.0	8.5	52.5	47.5
5	81	5.0	4.5	9.5	——	——
6	79	6.0	5.0	11.0	——	——
7	78	7.0	6.0	13.0	——	——
8	76	7.2	6.0	13.2	54.0	46.0
9	74	7.5	6.0	13.5	——	——
10	69	8.0	6.2	14.2	——	——
11	69	8.0	6.0	14.0	——	——
12	69	8.0	6.5	14.5	56.0	44.0
13	42[b]	5.0	4.0	9.0	——	——
14	42	7.0	5.0	12.0	——	——
15	41	7.0	6.0	13.5	——	——
16	41	8.0	6.5	14.5	55.7	44.3
17	41	8.0	6.6	14.6	——	——
18	40	8.0	7.0	15.0	——	——
19	40	8.2	7.0	15.2	——	——
20	40	8.2	7.0	15.2	54.0	46.0
21	40	8.4	7.2	15.6	——	——
22	40	9.0	7.5	16.5	——	——
23	40	9.0	7.6	16.6	——	——
24	40	10.0	8.0	18.0	54.6	49.4
Total......	——	165.5	136.9	302.4	54.8	45.2

[a] Incubator eggs used up to two weeks = 28.

[b] Cockerels removed.

[c] Computed in 4-week periods.

TABLE 6

Total amount and proportion of feed consumed at different ages in lot III of chicks (June 29, 1929 to December 16, 1929)

NUMBER OF WEEKS	TOTAL NUMBER OF BIRDS	TOTAL CONSUMPTION			PERCENTAGES[c]	
		Grain	Mash	Total	Grain	Mash
		kgm.	*kgm.*	*kgm.*	*per cent*	*per cent*
1	84[a]	2.5	2.2	4.7	——	——
2	84[a]	3.0	3.0	6.0	——	——
3	84	4.0	4.0	8.0	——	——
4	78	5.0	5.0	10.0	50.5	49.5
5	78	6.0	6.0	12.0	——	——
6	76	6.0	6.0	12.0	——	——
7	75	6.0	6.0	12.0	——	——
8	74	7.0	7.0	14.0	50.0	50.0
9	72	7.0	7.0	14.0	——	——
10	64	7.0	7.0	14.0	——	——
11	64	7.0	7.0	14.0	——	——
12	64	7.0	7.0	14.0	50.0	50.0
13	33[b]	4.0	4.0	8.0	——	——
14	33	5.0	5.0	10.0	——	——
15	30	6.0	6.0	12.0	——	——
16	30	7.0	7.0	14.0	50.0	50.0
17	30	7.0	7.0	14.0	——	——
18	30	7.0	7.0	14.0	——	——
19	30	6.6	7.0	13.6	——	——
20	30	7.2	7.0	14.2	49.8	50.2
21	30	7.0	7.0	14.0	——	——
22	30	8.0	8.0	16.0	——	——
23	30	8.0	8.0	16.0	——	——
24	30	8.0	8.0	16.0	50.0	50.0
Total......	——	148.2	148.2	296.5	50.0	50.0

[a] Incubator used up to two weeks = 28.

[b] Cockerels removed.

[c] Computed in 4-week periods.

TABLE 7

Showing the cost of feeds necessary to produce weanlings

FEEDS	LOT I		LOT II		LOT III	
	Amount	Cost	Amount	Cost	Amount	Cost
	kgm.	*pesos*	*kgm.*	*pesos*	*kgm.*	*pesos*
Cracked corn	40.7	3.38	——	——	——	——
Palay	43.1	3.58	——	——	——	——
Corn meal	27.6	3.09	——	——	——	——
Copra meal	4.5	.35	——	——	——	——
Rice bran	17.8	1.28	——	——	——	——
Shrimps	19.5	4.18	——	——	——	——
Grain	——	——	69.2	6.23	67.5	6.09
Mash	——	——	57.5	5.75	67.2	6.20
Total	146.1	15.86	126.7	11.98	134.7	12.29
Total (computed for every 100 birds) weaned	221.4	24.03	183.6	17.36	210.5	19.20

TABLE 8

Showing the cost of feeds necessary to produce pullets from weanlings

FEEDS	LOT I		LOT II		LOT III	
	Amount	Cost	Amount	Cost	Amount	Cost
	kgm.	*pesos*	*kgm.*	*pesos*	*kgm.*	*pesos*
Corn	62.8	5.78	——	——	——	——
Palay	54.0	4.48	——	——	——	——
Corn meal	21.8	2.44	——	——	——	——
Copra meal	8.6	.67	——	——	——	——
Rice bran	20.6	1.49	——	——	——	——
Shrimps	17.8	3.72	——	——	——	——
Grain	——	——	96.3	8.67	80.8	7.27
Mash	——	——	79.4	7.94	81.0	8.10
Total	186.6	18.58	175.7	16.61	161.8	15.37
Total (computed for every 100 raised to maturity	622.0	61.93	439.2	41.52	539.2	51.23

TABLE 9

Cost to produce birds and the cost of feeds consumed

ITEMS	LOT I		LOT II		LOT III	
	Weight	Value	Weight	Value	Weight	Value
	kgm.	*pesos*	*kgm.*	*pesos*	*kgm.*	*pesos*
Value of cockerels weaned[a]	13.9	11.12	12.1	9.68	14.4	11.52
Value of pullets 24 weeks old[b]	32.8	26.32	41.2	32.96	32.6	26.08
Totals	46.7	37.44	53.3	42.64	47.0	37.60
Amount and cost of feeds	332.7	34.93	302.4	28.59	296.5	27.66
Value of birds over the cost of feeds	——	2.51	——	14.05	——	9.94
Cost of feeds per pullet raised to 24 weeks old	11.1	1.16	7.6	0.71	9.9	0.92

[a] Weanling cockerels were valued at ₱0.80 a kgm. live weight.

[b] The pullets were valued also at ₱0.80 a kgm. live weight.

TABLE 10

Maturity of the pullets raised

ITEMS	LOT I	LOT II	LOT III
Date hatched	June 27, 1929	June 27, 1929	June 27, 1929
Date first egg was laid	Dec. 4, 1929	Dec. 6, 1929	Dec. 3, 1929
Age when first egg was laid	161 days	163 days	160 days
Number of pullets raised to 24 weeks	30	40	30
Percentage of pullets laying at 24 weeks of age	16.7	10.00	16.7
Number of eggs collected up to 24 weeks	49	29	47
Value of eggs laid up to 24 weeks at ₱0.04	₱1.96	₱1.16	₱1.88
Number of eggs collected for every 100 pullets at 24 weeks	163	73	157
Value of eggs laid computed for every 100 pullets at 24 weeks	₱6.52	₱2.88	₱6.28

TABLE 11

Showing the percentage of mortality in three lots
(June 29, 1929 to December 16, 1929)

PERIOD IN WEEKS	LOT I			LOT II			LOT III		
	Total number of birds	Mortality	Percentage of mortality	Total number of birds	Mortality	Percentage of mortality	Total number of birds	Mortality	Percentage of mortality
1– 4 weeks..........	85	2	2.4	85	3	3.5	85	7	8.2
5– 8 weeks..........	82	6	7.3	82	6	7.3	78	6	7.7
9–12 weeks..........	76	10	13.2	76	7	9.2	72	8	11.1
13–16 weeks..........	32[a]	1	3.1	42	2	4.8	33	3	9.1
17–20 weeks..........	31	1	3.2	40	0	0	30	0	0
21–24 weeks..........	30	0	0	40	0	0	30	0	0
Total................		20			18			24	

[a] Cockerels removed.

TABLE 12

Showing the average weight of the layers
(September 1, 1928 to August 31, 1929)

MONTHS	LOT I		LOT II		LOT III	
	Number of birds	Grams	Number of birds	Grams	Number of birds	Grams
September.	25	1079.0	25	1093.4	25	1187.8
October...	24	1106.7	24	1152.7	25	1261.0
November.	22	1312.5	24	1347.7	25	1298.9
December.	22	1349.1	23	1356.5	25	1296.9
January...	22	1371.2	23	1372.4	25	1426.1
February..	22	1439.8	23	1417.0	23	1397.7
March....	22	1416.4	23	1368.5	23	1466.7
April......	21	1493.2	23	1480.9	23	1380.7
May......	21	1386.9	23	1377.7	23	1273.8
June......	21	1398.6	23	1383.9	23	1462.5
July......	21	1435.3	23	1418.2	23	1420.3
August....	21	1443.9	23	1430.5	22	1274.3

TABLE 13

Showing the amount of feeds consumed at different periods, lot I of layers (September 1, 1928 to August 31, 1929)

MONTHS	NUMBER OF BIRDS	GRAIN		MASH				TOTAL
		Corn	Palay	Corn meal	Copra meal	Rice bran	Shrimps	
		kgm.	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*
September...	25	27.2	15.5	8.9	1.3	4.6	4.4	61.9
October.....	24	24.8	14.2	6.7	1.3	2.7	4.3	54.0
November...	22	18.2	10.4	5.2	1.9	3.5	5.0	44.2
December...	22	17.2	19.1	2.9	0.6	2.4	4.4	46.6
January.....	22	22.3	16.3	5.9	1.4	0.9	5.6	52.4
February....	22	19.0	17.4	7.2	1.6	1.2	6.6	53.0
March......	22	22.6	17.1	4.1	3.4	1.9	8.0	57.1
April.......	21	18.9	20.1	4.7	3.0	2.2	3.0	51.9
May........	21	18.9	19.3	4.6	2.5	2.4	3.0	50.7
June........	21	19.1	18.1	4.5	2.5	2.4	2.4	49.0
July........	21	22.4	17.3	5.0	2.5	4.6	4.4	56.2
August......	21	20.4	16.1	5.4	2.3	4.6	3.4	52.2
Total.......	—	251.0	200.9	65.1	24.3	33.4	54.5	629.2

TABLE 14

Showing the amount of feeds consumed expressed in proportion or percentages, lot I of layers (September 1, 1928 to August 31, 1929)

PERIOD IN MONTHS	TOTAL NUMBER OF BIRDS	GRAIN			MASH					TOTAL FEED	PER-CEN-TAGE OF GRAIN	PER-CEN-TAGE OF GRAIN
		Corn	Palay	Total	Corn meal	Copra meal	Rice bran	Shrimps	Total			
		per cent	*per cent*	*kgm.*	*per cent*	*per cent*	*per cent*	*per cent*	*kgm.*	*kgm.*		
Sept.-Dec..	25	59.6	40.4	146.6	39.4	8.5	22.0	30.1	60.1	207.7	70.9	29.1
Jan.-April..	22	53.9	46.1	153.7	36.1	15.5	10.2	38.2	60.7	214.4	71.7	28.3
May-Aug..	21	53.3	46.7	151.6	34.5	17.3	24.8	23.4	56.5	207.1	72.8	27.2
Total for the year...		55.5	44.5	451.9	36.7	13.7	18.8	30.7	177.3	629.2	71.8	28.2

TABLE 15

Showing the amount and proportions of feed consumed in 12 months, lot II of layers (September 1, 1928 to August 31, 1929)

PERIOD IN MONTHS	TOTAL NUMBER OF BIRDS	TOTAL CONSUMPTION			PERCENTAGES	
		Grain	Mash	Total	Grain	Mash
		kgm.	*kgm.*	*kgm.*	*per cent*	*per cent*
Sept.-Dec.	25	159.6	60.1	220.7	72.3	27.7
Jan.-April.....	23	154.5	52.9	207.4	74.5	25.5
May-Aug.	23	135.2	47.0	182.2	74.2	25.8
Total.........		449.3	160.0	609.3	73.7	26.2

TABLE 16

Showing the amount and proportion of feed consumed in 12 months, lot III of layers (September 1, 1928 to August 31, 1929)

PERIOD IN MONTHS	TOTAL NUMBER OF BIRDS	TOTAL CONSUMPTION			PERCENTAGES	
		Grain	Mash	Total	Grain	Mash
		kgm.	*kgm.*	*kgm.*	*per cent*	*per cent*
Sept.-Dec.	25	118.0	118.0	236.0	50.0	50.0
Jan.-April.....	25	133.0	133.0	266.0	50.0	50.0
May-Aug.	23	117.0	112.3	229.3	51.0	49.0
Total.........		368.0	363.3	731.3	50.3	49.7

TABLE 17

The comparison of the number and percentages of eggs laid (September 1, 1928 to August 31, 1929)

MONTHS	LOT I		LOT II		LOT III	
	Number of eggs	Per cent	Number of eggs	Per cent	Number of eggs	Per cent
September..............	72	9.6	91	7.13	202	26.93
October................	262	34.76	170	22.84	209	27.99
November..............	218	31.14	193	26.80	153	21.98
December..............	196	28.49	271	36.42	162	22.67
January................	246	36.07	254	34.47	173	24.26
February...............	255	39.96	269	40.34	300	47.02
March..................	247	37.94	237	33.23	251	38.55
April..................	254	40.31	260	37.68	315	48.38
May....................	234	35.94	240	33.66	247	37.94
June...................	208	33.01	213	30.86	241	37.01
July...................	226	34.71	263	36.88	269	41.32
August.................	233	33.79	243	34.08	215	33.02
Total eggs produced.....	2,651	——	2,704	——	2,737	——

TABLE 18

Showing cost of feeds consumed by layers

FEEDS	LOT I		LOT II		LOT III	
	Amount	Cost	Amount	Cost	Amount	Cost
	kgm.	*pesos*	*kgm.*	*pesos*	*kgm.*	*pesos*
Corn	150.0	23.09	——	——	——	——
Palay	200.9	16.67	——	——	——	——
Corn meal	65.1	7.28	——	——	——	——
Copra meal	24.3	1.89	——	——	——	——
Rice bran	33.4	2.40	——	——	——	——
Shrimps	54.5	11.68	——	——	——	——
Grain	——	——	449.3	40.44	368.0	33.12
Mash	——	——	160.0	16.00	363.3	36.33
Total	629.2	63.01	609.3	56.44	731.3	69.45
Feed consumed per bird	30.0	3.00	26.5	2.50	33.2	3.17

TABLE 19

Showing the cost of feeds needed for egg production

ITEMS	LOT I	LOT II	LOT III
Number of eggs laid	2,651	2,704	2,737
Value of eggs at ₱0.05 each	₱132.55	₱135.20	₱136.85
Amount of feeds consumed	629.2 kgm.	609.3 kgm.	731.3 kgm.
Cost of feeds	₱ 63.01	₱ 56.44	₱ 69.45
Value of eggs over cost of feeds	₱ 69.54	₱ 78.76	₱ 67.40
Value of eggs over cost of eggs computed for every 100 layers	₱316.09	₱338.02	₱283.49

TABLE 20

Comparison of mortality

LOT NO.	I	II	III
Number of birds at start	25	25	25
Birds that died	4	2	3
Percentage mortality	16	8	12

A STUDY OF THE FOODS SERVED BY FOUR RESTAURANTS IN THE COLLEGE OF AGRICULTURE[1]

ISIDRO S. SAMIA

INTRODUCTION

The amount of food required by an average Filipino college student has never been determined. As an institution interested in the well-being of its students, this College of Agriculture should study the quality and amount of the food that is being served to the students. Hence, the study reported in this paper was undertaken. The work was concentrated on the meals served in four restaurants where many of the students board.

Scope of the present work

The object of the present work was to determine the quality and the protein and ash contents of the foods served at the four restaurants where observations were made.

Time and place of the present work

This work was begun in April, 1928, and closed June, 1929. All analyses were performed in the advanced laboratory of the Department of Agricultural Chemistry, College of Agriculture.

Review of literature

The quality of a food is an approximate index of its nutritive value, especially when the vitamin contents are to be considered. It is known that a dietary containing a liberal supply of milk, vegetables, and fruits cannot be poor in vitamins. Foods that include much cereal are rich in carbohydrates; foods that include much meat and legumes are rich in proteins. Vegetables and fruits are good sources of minerals.

In a dietary study conducted by Wait (1895) in the College Club of the University of Tennessee, the subjects being 41 students, mostly men, with an average age of 21.6 years and average weight of 142 pounds, it was found that the average man ate about 93 grams of protein daily. This study was carried in the winter month of January, 1895, when the temperature registered a minimum of 7°F.

In the following summer (May, 1895) another study was conducted and each individual was found to consume daily an average of 88 grams of protein. This College Club was organized and run by sons of Tennessee farmers whose aim was to secure cheaper board than that served by the University boarding houses.

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Using as subjects a group of students in the College Club of the University of Missouri, Gibson, Calvert, and May (1895) found that the average man consumed 96 grams of protein a day.

According to the same investigators, the Students' Club at Wesley University, Middletown, Connecticut, consumed, on the average, 108 grams of protein a day.

With women as subjects, Southard, Richard, Usher, Terrill and Shapleigh (1903) found in their studies at the Boston School of Housekeeping, that under ordinary conditions each person consumed 93 grams of protein a day; under medium cost each person consumed 94 grams of protein a day; under low cost each person consumed 79 grams of protein a day, and under high cost each person consumed 118 grams of protein a day.

These investigators studied also the diet of 30 students in the Bible Normal College, Springfield, Massachusetts. These students willingly subjected themselves to strict economy; their aim was to save money to be used on a certain project. It was found that a balanced diet costing 10 cents a man a day gave an average daily protein ration of 75 grams a man. This diet, although comparatively low in protein, gave nearly the same nutritive value as was supplied in the Boston School of Housekeeping (2776 calories in the Housekeeping and 2,243 in the Bible Normal).

Gephart (1917) in his report on a dietary study of St. Paul's School, Concord, New Hampshire, found, among 350 students, that those with an average age of 13 years, 6 months consumed 152.4 grams of protein daily; those with an average age of 14 years and 7 months, 153.6 grams of protein daily; and those with an average age of 16 years and 1 month 145.8 grams of protein daily. The study was conducted for a period of one school year.

Kramer and Grundmeir (1926) found in their dietary survey among 465 students at the Kansas State Agricultural College, that the average man consumed 85 grams of protein a day. This study was conducted during the winter months.

Raitt (1926) made a survey in January and February of 1926 at the University of Washington in Seattle on 12 homes organized for women and found that each woman consumed about 80 grams of protein daily.

Roxas and Collado (1922) in their investigation on Filipino diet found that the students boarding in the Students' Mess (now Molawin Hall) consumed an average of 78.1 grams of protein daily, while the Filipino farmers in the locality consumed a daily average of 70.4 grams of protein. These figures show that the students and the laborers did not differ very much in their protein intake. These investigators attributed this low intake of protein to the excess of rice eaten; to the lack of means of the subjects to buy other food; and to the small amount of leguminous foods eaten. In their attempt to compare the protein intake of the Filipino laborer with that of the laborers in other countries, they found the Filipinos to be the lowest in protein consumption, thus showing that our farmers are poorly nourished.

These authors found that the average mineral salts consumed by their subjects ranged from 0.11 to 0.15 grams a day as compared to Sherman's standard of 0.67 grams per man daily. This low consumption was found to be due to the fact that over 80 per cent of the diet of their subjects was from grain or grain products.

According to their findings the food consisted for the most part of sugar, rice, fish, meat, vegetables, eggs, bread, corn, *miki*, *misua*, *sotangjon* (varieties of noodles), cocoa, milk, etc.

Santos (1923) in his metabolism experiment with Filipinos in the United States showed that students eating the food supplied freely by the investigator consumed more protein than the Filipinos used as subjects by Roxas and Collado in the Philippine Islands, or the Japanese students (cited by Santos, 1923), and that his subjects approached the accepted American and European standard per kilogram of body weight. In contrast to the food consumed by the subjects of the investigators in the Philippine Islands, Santos used more nitrogenous foods, and supplied them freely. His findings show that if Filipinos have the means to buy food they are capable of consuming protein in the amounts that Americans and Europeans do.

As evidence of the inadequacy of the mineral salts in the common Filipino diet, Santos (1923) cited every day happenings as: (*a*) bones of fish are usually eaten as well as the flesh, and dry fish is a very common food; (*b*) while as a rule unmarried Filipino women do not chew buyo and betel leaves nor smoke tobacco or cigarettes, when they, especially the poorer ones, marry and become pregnant or when they are nursing children, they form the "buyo chewing" habit and even eat the ash of cigars or cigarettes. Some, it is said, eat this ash although they dislike the odor of tobacco.

Concepción (1928) in his investigation on the diet of Manila students of the University of the Philippines found that the food served to them was for the most part fresh although sometimes meat and fish that had been frozen were bought. It was noticed during the course of the several investigations, that milk, leaf vegetables, and fresh fruits were served in inadequate quantities. Rice and its products was found to constitute an important bulk in the students' diet. It was further revealed that the breakfast served (consisting of ham, eggs, etc.) was more expensive than either the dinner or supper.

The quality and palatability of the food served to the University of the Philippines students in Manila in the report of 1928 was found to be far superior to that served in the Molawin Hall (Students' Mess) as reported by Roxas and Collado (1922).

MATERIALS AND METHODS

For this investigation the four restaurants studied were named A, B, C, and D. The average number of boarders were 100, 60, 40, and 60, respectively.

Restaurants B and C are private concerns, hence are conducted for profit. As restaurant A is run by College authorities profit is not the aim. Restaurant D is under an institution. From the beginning of its organization to January, 1929, this restaurant was under the management of the institution and profit was not the aim. In this month the restaurant was leased to a man who desired, of course, to make a profit.

The foods were gathered and prepared for analysis in the following ways: Regular meals from each of the restaurants were bought from time to time. This food was placed in food containers and taken to the laboratory for analysis. In case time was insufficient to analyze these samples before there was decomposition, alcohol was used as preservative.

The food served for each meal was arbitrarily divided into two groups, basal diet, or *canin* (Tagalog) and supplement, or *ulam* (Tagalog). By basal diet (*canin*) is meant either boiled rice or bread or both, while supplement (*ulam*) includes all other portions of the food eaten at the meal.

As the restaurants allow their boarders to have as much rice as they want it was deemed not necessary to determine the amount of rice eaten at each meal. Instead, several determinations were made and the mean was taken as the average intake of an average boarder. When bread is served the quantity is limited.

Several determinations showed that the four restaurants gave practically the same amount of bread. Most of the patrons of the four restaurants eat bread instead of rice for breakfast. When a boarder eats rice at any meal he is given as much as he wants, so it was assumed that the amount of basal diet, or *canin*, served by the four restaurants was the same.

The *ulam* given to the boarders is, of course, limited, and if the four restaurants differed in the amount of food served the difference would be in the supplement, or *ulam*. The supplement, or *ulam*, served at each meal was freed of inedible portions such as bones, peelings, etc., then it was mixed together and weighed and sampled for analysis.

Methods of analysis

The directions for the determination of moisture, proteins, and minerals were taken from the *Official and Tentative Methods of Analysis* compiled by the American Association of Official Agricultural Chemists (1925).

RESULTS AND DISCUSSIONS

The results of the analyses are given in tables 1, 2, 3, and 4.

The foods analyzed were those served to boarders who paid eighteen pesos (₱18.00) a month, at the four restaurants.

Quality. There was no appreciable difference in the quality of the foods served in the four restaurants. This was probably because the supply of food materials came from practically the same sources, mainly Los Baños, Bay, and Calamba. Restaurant A, alone, had meat sent from Manila once a week.

The most common food served was cereals, meat, fish, vegetables, sugars, and fruit, especially bananas.

The *ulam* from restaurant A did not differ very much from the other restaurants, except that it was more varied. The foods, rich in proteins in restaurant A, were more in quantity than in any one of the other three. For example, a breakfast consisted of *samporado* (chocolate, sugar, rice and milk), fish, peas, onions, eggs, and coffee. The eggs, fish, and peas are good sources of proteins while *samporado* is rich in carbohydrates. If sausages or eggs are served with onions, these are also rich in proteins.

For dinner and supper, food rich in proteins, such as beef, pork, fish, chicken, and shrimps were served. Owing to the high cost of these food materials only a little of them is given. The quantity is made up with vegetables, such as legumes and tubers.

Restaurant C served food of rather poorer quality than that of restaurant A and much less in dry weight and percentage of proteins.

The quality of the foods served in restaurant B did not differ greatly from that of restaurant C, but often the food served, although bulky, contained a less amount of protein. A typical example of this lower protein value is in the *ulam* served at breakfast. This is composed of four bananas, some scrambled eggs with potatoes. In such a meal the bananas and potatoes, which are primarily carbohydrate food, form the main bulk. The eggs are the principal source of protein, but they form a small portion of the whole bulk of the food.

Restaurant D furnished the same material as the other three restaurants, only beef and chicken were not served as often. Eggs, fish, pork, and legumes were the main sources of protein. It was found that during May, 1929, there was a predominance of carbohydrate foods. From January, 1929, when the management was leased, the quality of the food served was more varied and chicken and beef were more frequently served.

Protein. From the results of the analyses given in tables 1, 2, 3, and 4, it may be seen that the daily protein in *ulam* varies from 21.5 to 138.75 grams in restaurant A; from 25.04 to 75.89 grams in restaurant B; from 20.91 to 88.85 grams in restaurant C; and from 15 to 55.43 grams in restaurant D.

The average daily protein in the *ulam* of the four restaurants was:

Restaurant A........................	63.10 grams
Restaurant B........................	45.62 grams
Restaurant C........................	46.10 grams
Restaurant D........................	34:15 grams

If the average protein intake from rice and bread are added to the average protein in the *ulam* served by each of the four restaurants, the amount of total proteins each boarder received daily would be:

	AVERAGE DAILY PROTEIN IN ULAM	AVERAGE DAILY PROTEIN IN CANIN	AVERAGE TOTAL PROTEIN TAKEN DAILY
	grams	*grams*	*grams*
Restaurant A.......	63.10	35.24	98.34
Restaurant B.......	45.62	35.24	80.86
Restaurant C.......	46.10	35.24	81.34
Restaurant D.......	34.15	35.24	69.39

The highest average daily protein ration, as found above, was given by restaurant A amounting to 98.34 grams. This amount and that of restaurant C, 81.34 grams, and restaurant B, 80.86 grams, are greater than the average protein ration found by Roxas and Collado in their investigation on the Filipino diet in Los Baños eight years ago. Restaurant D exhibited a lower average daily protein quantity than that found by Roxas and Collado (1922) which was 78.1 grams a day. This amount was, however, found to be higher by 8.61 per cent than the food served in any of the men's dormitories at University of the Philippines, Manila. Santos (1923) found 76.6 grams of protein was the daily intake of Filipino students in Yale University. In the beriberi stricken area of Nueva Ecija and Cavite, he found a still lower protein daily intake among the people.

The daily protein supply at restaurant A (98.34 grams) can be compared favorably with that of the daily protein supply in the following institutions:

(*a*) College Club, University of Tennessee (1895) with an average daily protein ration of 91.1 grams.

(*b*) College Club, University of Missouri (1895) with an average daily protein ration of 96 grams.

(*c*) The Bible Normal College, Massachusetts (1902) with an average daily protein ration of 75 grams.

(*d*) Boston School of Housekeeping (1902) (women) with an average daily protein ration of 94 grams.

(*e*) Kansas State Agricultural College (1926) with an average daily protein ration of 85 grams.

(*f*) University of Washington (1926) (women) with an average daily protein ration of 80 grams.

(*g*) The Japanese students (cited by Santos, 1923) with an average daily protein ration of 53.75 grams.

Minerals. The amount of minerals in the daily *ulam*, served by the restaurants varied. It ranged from 4.95 grams to 23.74 grams at restaurant A; 5.43 grams to 15.46 grams at restaurant C; from 5.19 grams to 19.17 grams at restaurant B; and from 3.84 to 19.46 grams at restaurant D. In the *ulam* served there was an average daily mineral content of 12.37 grams at restaurant A; 9.70 grams at restaurant C; 10.63 grams at restaurant B; and 10.65 grams at restaurant D.

Roxas and Collado (1922) reported 13.93 grams of minerals as an average daily intake among the students boarding at Students' Mess (now Molawin Hall).

SUMMARY AND CONCLUSIONS

1. The quality, amount of proteins, and minerals in the food served by the four restaurants in the College of Agriculture were examined.

2. The quality of the foods served in the four restaurants was found to be in the following order:

First, restaurant A.
Second, restaurant C.
Third, restaurant B.
Fourth, restaurant D.

3. The average daily protein in the *ulam* in each restaurant was as follows:

Restaurant A	63.10 grams
Restaurant B	45.62 grams
Restaurant C	46.10 grams
Restaurant D	34.15 grams

4. The average daily mineral content from the *ulam*, served in the following restaurants was:—

Restaurant A	12.37 grams
Restaurant B	10.63 grams
Restaurant C	9.70 grams
Restaurant D	10.65 grams

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The quality, protein, and ash of the foods served by restaurant A

MEALS		AVERAGE MOISTURE	DRY WEIGHT	MINERALS	PROTEIN	PROTEIN PER MEAL	PROTEIN PER DAY	MINERALS PER MEAL	MINERALS PER DAY	DATE SERVED
		per cent	*grams*	*per cent*	*per cent*	*grams*	*grams*	*grams*	*grams*	
Breakfast	*Samporado*, fish, peas, onions, eggs, coffee	82.15	28.00	3.11	15.16	4.25	23.14	0.87	9.55	June 18, 1928
Dinner	Sweet potatoes, bananas, beef, cabbage, tomatoes, beans, fish, pork	58.52	35.00	10.30	22.72	7.95		3.55		
Supper	Beans, sausage, potatoes, beef, peas	52.71	46.00	11.04	23.78	10.94		5.08		
Breakfast	Sausage, eggs, onions	52.55	28.80	3.16	27.17	7.86	58.73	0.81	12.73	June 20, 1928
Dinner	Cabbage, meat, *pechay*	76.07	128.90	6.15	29.18	37.61		7.92		
Supper	*Tinapa*, eggs, tomatoes, sword beans	59.23	50.00	7.80	26.52	13.26		3.90		
Breakfast	Cocoa, peas, fish	73.61	34.00	3.54	17.42	5.92	21.50	1.20	6.90	June 28, 1928
Dinner	*Upo*, *bijon*, meat, *pechay*, chicken, onions, chocolate	63.53	37.00	8.58	19.21	7.11		3.18		
Supper	*Bañgos*, beans, meat, bananas	69.05	35.00	7.21	18.47	6.47		2.52		
Breakfast	Scrambled eggs, bananas, chocolate	62.32	61.00	4.83	21.28	12.98	64.20	2.95	17.37	July 9, 1928
Dinner	Meat, potatoes, bananas, fish	33.50	134.50	9.07	33.49	45.84		12.33		
Supper	*Bijon*, meat, *gabi*	66.86	38.30	5.48	16.22	6.21		2.10		
Breakfast	Fish, bananas, chocolate	71.13	35.60	3.14	14.59	5.19	31.51	1.12	9.06	November 7, 1928
Dinner	Beef, potatoes, *pechay*, pork	57.99	40.10	10.25	31.83	12.87		4.17		
Supper	Beans, beef, pork, fish	69.95	45.80	8.24	29.36	13.45		3.77		
Breakfast	Eggs, bananas, coffee	66.40	39.50	2.82	16.70	6.59	34.66	1.12	7.78	November 23, 2928
Dinner	Pork, potatoes, onions, *bañgos*	51.47	43.20	8.96	3.72	14.14		3.77		
Supper	Fish, tomatoes, cabbage, pork	54.75	37.90	7.63	36.76	13.93		2.89		
Breakfast	Scrambled eggs, sausage, cocoa	61.96	33.40	3.50	32.49	10.86	29.85	1.17	4.95	December 4, 1928
Dinner	Macaroni, pork, beef, potatoes	56.33	46.70	5.55	15.14	7.07		2.59		
Supper	Pork, cabbage, *pechay*	58.04	38.60	4.76	30.89	11.92		1.19		
Breakfast	Eggs, potatoes, bananas, cocoa	42.48	41.30	3.20	21.90	8.75	36.75	1.32	7.16	December 13, 1928
Dinner	Beans, pork, *bañgos*	53.91	35.90	5.63	34.87	12.52		2.02		
Supper	Meat, potatoes, fish, cake	48.67	46.50	8.22	33.29	15.48		3.82		
Breakfast	Fish, peas, cocoa, bananas, onions	79.29	40.20	3.20	17.30	69.55	39.25	1.29	8.87	January 9, 1929
Dinner	Beef, cabbage, tomatoes, pork, peas, *gabi*	62.97	47.80	6.70	38.34	18.33		3.21		
Supper	Fish, beef, potatoes, bananas	53.62	51.30	8.53	27.21	13.96		4.38		
Breakfast	Scrambled eggs, sausage, cocoa	71.28	29.10	3.69	25.76	7.50	29.77	0.97	7.81	January 25, 1929
Dinner	Chicken, pork, potatoes, onions	59.02	31.70	7.88	30.16	9.56		2.60		
Supper	*Tinapa*, tomatoes, beans, pork	50.77	46.00	9.23	27.63	12.71		4.24		
Breakfast	Eggs, ham, tomatoes, oatmeal, sugar	70.80	41.00	5.88	32.14	13.28	44.00	2.36	9.16	February 12, 1929
Dinner	*Sotangjon*, pork, cake, *upo*, potatoes, peas	72.31	48.00	6.22	18.26	8.77		2.98		
Supper	Beans, potatoes, pork, *tinapa*	65.22	51.00	8.36	23.46	11.96		4.27		
Breakfast	Cake, cocoa, eggs	64.60	115.00	2.71	60.30	69.35	93.00	3.12	10.09	April 6, 1929
Dinner	*Miki*, cake, chocolate, cabbage, beef, *pechay*	74.28	76.63	3.21	23.28	17.83		2.41		
Supper	Beef, potatoes, catsup, eggplant	30.46	62.76	4.07	8.05	5.82		2.56		
Breakfast	Egg, cocoa, bananas	45.46	111.04	2.36	16.89	18.32	79.72	3.62	14.50	April 7, 1929
Dinner	Chicken, pork, peas, glutinous rice, papaya, melon, sugar, pepper, raisins, eggs	66.43	120.80	5.06	22.27	26.99		76.13		
Supper	Chicken, peas, potatoes, cabbage, sausage	65.41	91.13	6.31	36.67	34.41		5.75		
Breakfast	Cocoa, pork, potatoes, onions	64.64	94.16	4.92	67.77	62.90	138.75	4.64	14.84	April 14, 1929
Dinner	Meat, peas, macaroni, cake, chocolate	57.34	102.37	4.62	58.59	59.76		4.71		
Supper	*Miki* onion, meat, cabbage	68.13	74.20	7.40	21.69	16.09		5.49		
Breakfast	Sardines, cocoa	69.73	67.60	6.86	80.76	58.65	98.24	4.97	13.64	May 18, 1929
Dinner	Eggs, cabbage, meat, *gulaman*, apples, bananas, peas, tomatoes, onions, *misua*	78.26	55.21	6.33	17.07	9.42		3.50		
Supper	Meat, potatoes, cabbage, chicken	66.41	91.13	5.68	33.11	30.17		5.17		
Breakfast	Eggs, tomatoes, coffee	37.70	66.23	5.34	8.50	5.63	33.45	3.53	23.74	May 19, 1929
Dinner	Cake, *upo*, beans, cabbage, pork, meat	46.96	239.29	5.32	7.67	18.33		12.70		
Supper	Pork, *cancong*, peas, eggs, cabbage	72.34	105.11	7.15	89.60	9.49		7.51		
Average	——	——	——	——	——	——	63.10	——	12.37	——

TABLE 2

The quality, protein, and ash of the foods served by restaurant B

MEALS		AVERAGE MOISTURE	DRY WEIGHT	MINERALS	PROTEIN	PROTEIN PER MEAL	PROTEIN PER DAY	MINERALS PER MEAL	MINERALS PER DAY	DATE SERVED
		per cent	*grams*	*per cent*	*per cent*	*grams*	*grams*	*grams*	*grams*	
Breakfast	Bananas, eggs, shrimps	62.99	40.80	7.46	14.14	5.77	25.04	2.99	10.70	June 18, 1928
Dinner	Beans, pork, chicken, potatoes	54.99	42.40	8.34	33.36	14.15		3.54		
Supper	*Bijon*, cabbage, onions, pork	65.35	49.10	8.52	13.12	5.12		4.18		
Breakfast	*Tinapa*, eggs, potatoes	44.53	26.50	9.62	40.95	10.85	40.22	2.55	10.52	June 28, 1928
Dinner	*Bañgos*, radish, pork, *gabi*, tomatoes	42.81	47.20	10.19	40.31	19.03		4.77		
Supper	Chicken, squash, eggplant, beans, meat, sweet potato leaves	52.21	30.20	10.60	34.23	10.34		3.20		
Breakfast	*Tinapa*, eggs, potatoes	44.53	26.00	9.62	43.38	11.28	32.55	2.50	8.56	July 8, 1928
Dinner	Meat, fish, shrimps, *cancong*, pepper leaves	45.27	24.20	10.83	43.14	10.44		2.62		
Supper	Chicken, shrimps, cabbage, *tokua*, pork	50.01	35.60	9.64	31.55	11.23		3.43		
Breakfast	Eggs, potatoes, fish, pork	48.42	28.90	6.57	38.21	11.04	57.69	1.90	10.22	July 24, 1928
Dinner	Mungo, fish, pork	52.00	76.10	5.81	40.51	30.83		4.42		
Supper	Fish, *bijon*, cabbage, pork	48.95	51.80	7.52	30.34	15.72		3.90		
Breakfast	Egg, bananas, butter	49.27	31.50	7.49	17.19	5.42	27.74	2.35	9.28	September 9, 1928
Dinner	Cabbage, *bijon*, pork, fish	63.23	48.60	8.21	15.84	7.70		3.99		
Supper	Meat, chicken, onions, potatoes	51.24	35.30	8.54	41.42	14.62		3.02		
Breakfast	Egg, bananas, butter	45.39	29.80	7.61	16.53	4.93	35.19	2.27	9.68	September 12, 1928
Dinner	Mungo, shrimps, pork, chicken	56.30	69.90	6.97	30.41	21.25		4.87		
Supper	Eggplant, fish, pork, beans	61.61	31.50	8.08	28.62	9.02		2.55		
Breakfast	*Tinapa*, eggs	34.28	23.40	10.70	40.54	9.50	34.46	2.51	8.40	December 6, 1928
Dinner	Pork, chicken, potatoes, onion	50.83	32.80	9.17	32.91	10.79		2.51		
Supper	Beans, pork, bananas	57.46	41.30	8.21	33.44	13.81		3.39		
Breakfast	Pork, potatoes, bananas	43.82	35.10	8.73	19.17	6.73	34.14	3.06	9.42	December 7, 1928
Dinner	Chicken, pork, radish, onions	65.50	39.60	9.57	33.57	14.09		3.78		
Supper	Beans, pork, shrimps, fish	49.21	42.00	6.14	31.70	13.32		2.58		
Breakfast	*Tinapa*, bananas	51.34	31.40	10.20	21.29	6.69	44.11	4.33	15.87	January 18, 1929
Dinner	Mungo, shrimps, fish, chicken	55.13	73.80	9.71	29.77	21.97		7.16		
Supper	*Upo*, pork, *bañgos*	41.78	49.70	8.02	31.09	15.45		3.99		
Breakfast	Eggs, bananas	54.42	30.60	7.50	16.84	5.17	32.12	2.30	10.04	January 25, 1929
Dinner	Chicken, papaya, meat	68.07	29.90	9.84	39.12	11.70		2.94		
Supper	Beef, pork, *bagoong*	45.42	37.40	12.85	40.78	15.25		4.81		
Breakfast	Scrambled eggs, bananas	52.56	31.50	5.65	16.21	17.17	31.07	1.78	5.19	February 12, 1929
Dinner	Fish, beans, pork, coconut milk	71.16	36.60	4.86	31.11	11.39		1.57		
Supper	*Misua*, pork, potatoes	80.55	25.10	7.31	10.03	2.52		1.83		
Breakfast	Eggs, cocoa, butter	69.72	53.00	2.42	22.45	11.60	75.92	1.28	5.96	April 8, 1929
Dinner	Bananas, chicken, pork, *upo*, *tinapa*	72.30	92.70	2.62	45.20	41.90		2.44		
Supper	Pork, beef, potatoes	56.20	49.92	8.81	45.95	22.42		2.24		
Breakfast	Eggs, *samporado*	67.60	53.92	1.80	16.71	8.80	26.76	0.97	19.17	April 9, 1929
Dinner	*Lechon*, fish, potatoes	69.36	27.58	5.99	50.33	13.88		13.91		
Supper	Fish, cabbage, chicken	70.59	44.12	9.70	9.03	3.98		4.29		
Breakfast	Eggs, *bañgos*, *tinapa*	51.00	39.71	7.57	48.55	19.28	58.53	3.01	10.11	May 18, 1929
Dinner	Chicken, meat, cabbage	76.08	50.01	8.08	61.54	30.78		4.04		
Supper	Meat, potatoes	76.67	47.32	5.01	10.66	8.47		5.06		
Breakfast	Eggs, *tuyo*, cocoa	61.60	82.90	7.12	60.80	50.40	75.89	5.91	13.62	May 19, 1929
Dinner	Potatoes, chicken, pork	23.24	39.75	7.85	44.32	14.00		3.12		
Supper	Pork, bananas, meat, cocoa, onions	39.22	53.16	8.52	17.17	11.49		4.59		
Breakfast	Oatmeal, eggs, onion, potatoes	26.57	51.14	2.45	34.36	17.52	40.03	1.26	5.71	May 28, 1929
Dinner	Fish, cabbage, cocoa, pork	25.96	32.00	5.17	14.78	4.73		1.65		
Supper	Pork, chicken, *cancong*, eggplant, onion, tomatoes	20.66	30.93	9.07	57.46	17.78		2.80		
Average	——	——	——	——	——	——	45.62	——	10.63	

TABLE 3

The quality, protein, and ash of the foods served by restaurant C

MEALS		AVERAGE MOISTURE	DRY WEIGHT	MINERALS	PROTEIN	PROTEIN PER MEAL	PROTEIN PER DAY	MINERALS PER MEAL	MINERALS PER DAY	DATE SERVED
		per cent	*grams*	*per cent*	*per cent*	*grams*	*grams*	*grams*	*grams*	
Breakfast..	Eggs, onions, fish	36.10	26.00	6.41	28.80	7.49	20.91	1.67	5.96	June 21, 1928
Dinner....	Chicken, beef, bananas, beans, onions, potatoes, tomatoes..	61.44	32.00	6.26	26.74	8.56		2.00		
Supper....	Beef, *upo*, potatoes, *pechay*, pork	73.54	40.50	5.67	9.99	4.05		2.31		
Breakfast..	Eggs, sausage	53.75	22.00	5.14	31.15	6.85	39.24	1.13	7.82	June 30, 1928
Dinner....	Meat, *pechay*, cabbage, potatoes	51.12	52.80	5.59	35.26	18.62		2.95		
Supper....	*Bañgos*, macaroni, cabbage, pork	60.93	54.88	5.53	25.12	13.77		3.03		
Breakfast..	Eggs, *tuyo*	34.93	25.50	14.54	49.41	12.61	57.96	3.71	10.79	July 5, 1928
Dinner....	Bananas, cabbage, chicken, pork, potatoes, macaroni	60.75	87.80	5.93	25.82	22.67		5.21		
Supper....	Beef, *pechay*, potatoes, pork	44.65	47.70	3.20	47.56	22.68		1.52		
Breakfast..	Eggs, *tuyo*	43.70	28.60	14.21	41.35	11.83	44.71	4.06	8.82	July 28, 1928
Dinner....	Fish, pork, cabbage, potatoes, bananas	63.79	38.70	7.86	32.37	12.53		3.04		
Supper....	Beans, *gabi*, *pechay*, meat, onions	49.57	60.40	2.84	33.69	20.36		1.71		
Breakfast..	Eggs, beef	47.26	29.20	8.46	44.81	13.08	52.30	2.49	7.19	August 3, 1928
Dinner....	Cabbage, chicken, potatoes, pork	60.61	38.20	5.83	20.45	7.81		2.32		
Supper....	Pork, eggs, beans, potatoes	57.44	43.20	5.50	27.57	11.91		2.37		
Breakfast..	Eggs, beef	49.93	29.20	8.46	44.89	13.11	33.55	1.81	6.32	September 11, 1928
Dinner....	Fish, meat, potatoes, cabbage	62.98	35.00	5.32	30.79	10.78		1.85		
Supper....	Meat, cabbage, *upo*	52.31	29.00	8.80	33.31	9.66		2.55		
Breakfast..	Eggs, *tuyo*	52.28	20.30	14.84	29.66	6.02	24.03	3.01	7.47	November 6, 1928
Dinner....	Cabbage, pork, beef, pechay, potatoes	64.94	36.50	6.56	29.22	10.67		2.39		
Supper....	Chicken, potatoes, fish	57.10	27.10	7.28	26.56	7.20		1.96		
Breakfast..	Eggs, beef, potatoes	46.59	27.30	8.24	29.05	9.93	29.28	2.25	6.02	November 21, 1928
Dinner....	Chicken, potatoes, beef, beans, bananas	47.02	36.80	6.31	22.22	7.96		2.26		
Supper....	Beef, potatoes, *pechay*, fish	62.56	29.10	5.20	39.15	11.39		1.51		
Breakfast..	Scrambled eggs, potatoes, sausage	47.93	23.80	5.38	33.71	8.02	31.07	1.28	6.61	December 3, 1928
Dinner....	Fish, cabbage, pork, shrimps	56.74	30.20	9.64	31.15	9.41		2.91		
Supper....	Macaroni, pork, cabbage	45.02	46.70	5.17	29.54	13.64		2.42		
Breakfast..	Eggs, fish	41.51	29.50	6.83	41.31	24.32	45.55	2.02	5.98	January 7, 1929
Dinner....	Chicken, papaya, fish	54.36	38.90	5.15	30.63	8.03		2.00		
Supper....	Meat, *upo*, pork, shrimps	56.29	37.60	5.23	35.10	13.20		1.97		
Breakfast..	Eggs, onions, potatoes	41.56	28.20	4.22	19.50	5.57	18.02	1.90	5.87	February 1, 1929
Dinner....	Beans, pork, potatoes, pepper	63.25	39.60	6.50	16.11	6.38		2.57		
Supper....	Potatoes, pork, eggplant, beans	70.41	28.90	4.82	21.00	6.07		1.39		
Breakfast..	Butter, oatmeal, eggs, milk	79.90	48.34	6.16	18.94	9.55	67.34	2.98	14.91	April 6, 1929
Dinner....	Cabbage, *upo*, shrimps, pork	77.77	34.45	9.53	40.01	13.80		3.29		
Supper....	Fish, beef, onions, tomatoes	67.18	106.54	8.19	42.14	44.39		8.64		
Breakfast..	Egg, potatoes, onions, milk, oatmeal	73.38	65.46	9.25	13.89	9.82	60.43	6.06	15.46	April 7, 1929
Dinner....	Chicken, *upo*, potatoes, pepper leaves	76.10	54.41	9.34	66.55	36.23		5.08		
Supper....	*Pechay*, beans, pepper, pork, shrimps	75.55	38.62	1.12	37.23	14.38		4.32		
Breakfast..	Eggs, potatoes, oatmeal	74.50	51.23	2.45	20.39	10.44	35.64	1.26	5.43	April 9, 1929
Dinner....	Fish, *upo*, tomatoes	59.74	32.95	7.94	56.63	18.69		2.62		
Supper....	Pork, beans, *misua*	64.58	20.33	7.53	29.75	6.51		1.53		
Breakfast..	Butter, oatmeal, meat, eggs	68.55	63.93	2.34	54.00	34.52	88.85	1.50	11.30	May 18, 1929
Dinner....	*Upo*, pork, meat	70.90	67.53	6.28	66.61	43.96		4.24		
Supper....	*Upo*, meat, chicken, cabbage, potatoes	83.80	54.26	9.93	19.10	10.37		5.39		
Breakfast..	Egg, oatmeal, butter	30.85	152.90	2.43	9.12	13.95	37.84	3.72	13.68	May 22, 1929
Dinner....	Meat, pork, *pechay*, potatoes	78.37	63.69	1.14	13.47	8.60		7.26		
Supper....	Meat, cabbage	62.06	30.26	8.91	49.28	15.29		2.70		
Average...	——	——	——	——	——	——	46.10	——	9.70	——

TABLE 4

The quality, protein, and ash of the foods served by restaurant D

MEALS		AVERAGE MOISTURE	DRY WEIGHT	MINERALS	PROTEIN	PROTEIN PER MEAL	PROTEIN PER DAY	MINERALS PER MEAL	MINERALS PER DAY	DATE SERVED
		per cent	*grams*	*per cent*	*per cent*	*grams*	*grams*	*grams*	*grams*	
Breakfast	Eggs, coffee	64.73	18.50	3.10	29.41	5.44	14.99	5.73	5.89	June 20, 1928
Dinner	Cake, macaroni, pork, shrimps, potatoes, onions	56.91	56.50	6.66	10.70	6.05		3.76		
Supper	Pork, beans, potatoes, onions	68.02	17.20	9.02	20.35	3.50		1.55		
Breakfast	Salmon, eggs onions	49.88	19.50	6.20	43.32	7.35	33.38	1.21	7.41	June 6, 1928
Dinner	Cake, pork, beans, *gabi*, *cancong*, eggplant	50.91	48.80	6.20	19.48	9.51		3.02		
Supper	Pork beans, sweet potato, onions, bananas	59.63	71.00	4.48	23.08	16.53		3.18		
Breakfast	Eggs, coffee, butter	79.46	21.30	3.22	39.40	8.39	31.77	0.55	6.79	June 10, 1928
Dinner	Fish, radish, cabbage, beans, shrimps	61.34	34.00	6.57	17.92	13.40		2.23		
Supper	Beans, pork, fish	31.46	46.80	8.57	21.33	9.98		4.01		
Breakfast	Eggs, cocoa, butter	63.53	19.70	3.57	39.82	7.26	21.07	0.70	3.84	August 9, 1928
Dinner	Macaroni, pork, potatoes, onions	79.33	36.20	4.41	12.27	4.44		1.60		
Supper	Potatoes, pork, cabbage, *tinapa*	45.50	38.50	3.92	24.34	9.37		1.54		
Breakfast	Fish, onions, coffee, butter	69.33	37.40	3.65	18.69	5.12	20.59	1.00	6.27	September 11, 1928
Dinner	Beef, sweet potato leaves, onions, eggplant, beans	62.54	40.60	5.85	20.15	8.18		2.38		
Supper	*Bañgos*, *bijon*, pork, cabbage	61.97	43.00	6.73	16.94	7.28		2.90		
Breakfast	Eggs, coffee, onions, butter	58.88	22.30	3.18	39.41	8.79	29.69	0.71	6.35	November 6, 1928
Dinner	Cake, beans, onions, pork, eggplant	64.49	36.80	7.16	29.22	10.75		2.64		
Supper	Beef, potatoes, onions, beans	53.45	43.20	6.96	25.80	10.15		3.01		
Breakfast	Cake, eggs, coffee, butter	78.50	26.70	3.54	27.96	6.81	46.70	0.96	6.77	November 21, 1928
Dinner	Macaroni, pork, radish, onions	70.86	49.20	6.01	10.80	5.31		2.96		
Supper	Fish, meat, onions	57.65	34.50	8.32	34.58	11.93		2.87		
Breakfast	Eggs, coffee, butter	72.38	20.00	3.13	29.34	5.87	23.09	0.63	4.10	December 3, 1928
Dinner	Beans shrimps, fish	71.51	38.10	4.78	23.90	9.11		1.82		
Supper	Potatoes, pork, beans	61.17	40.90	4.05	19.85	8.12		1.66		
Breakfast	Eggs, coffee, butter	70.76	31.00	4.36	23.46	7.27	34.82	1.25	5.12	January 2, 1929
Dinner	Chicken, meat, potatoes	56.13	45.20	5.49	33.69	15.23		2.48		
Supper	Fish, onions, meat	53.92	38.70	3.87	31.82	12.31		1.39		
Breakfast	Meat, coffee, butter	49.30	29.20	2.89	28.41	7.30	33.73	0.84	5.54	February 1, 1929
Dinner	Bird, potatoes, meat	41.60	44.10	4.28	31.90	14.07		1.89		
Supper	*Miki*, pork, beef, onions	53.80	50.20	5.62	24.62	12.30		2.82		
Breakfast	Coffee, eggs	86.62	22.50	3.91	29.34	6.59	30.34	8.80	15.62	April 4, 1929
Dinner	Pork, *upo*, shrimps, bananas	72.07	111.00	5.15	13.57	15.10		5.72		
Supper	Fish, meat, potatoes	59.52	22.30	4.93	41.54	8.64		1.10		
Breakfast	Eggs, coffee	86.62	22.50	3.91	29.34	6.59	55.43	8.80	15.91	April 5, 1929
Dinner	Onions, meat, potatoes, shrimps, tomatoes, cabbage	93.72	18.00	9.53	54.84	9.87		1.72		
Supper	*Upo*, chicken, onions, meat	61.65	79.00	6.82	49.23	38.86		5.39		
Breakfast	Eggs, coffee	86.62	22.50	3.91	29.34	6.59	20.98	8.80	11.34	April 6, 1929
Dinner	Pork, beef, fish, tomatoes	88.00	25.00	4.28	34.64	8.66		1.07		
Supper	Chicken, *upo*, pork, potatoes	88.15	16.00	9.17	35.75	5.73		1.47		
Breakfast	Eggs, coffee	86.62	22.50	3.91	29.34	6.59	13.34	8.80	13.98	April 7, 1929
Dinner	Bananas, beef, pork, cabbage, potatoes	75.18	65.26	5.89	26.83	17.50		3.95		
Supper	Fish, beef, squash, tomatoes	88.43	16.00	8.32	43.92	7.25		1.33		
Breakfast	Eggs, coffee	86.62	22.50	3.91	29.34	6.59	45.67	8.80	19.46	April 8, 1929
Dinner	*Cancong*, *miki*, pork, shrimps	59.87	73.26	7.54	27.32	20.02		8.70		
Supper	Fish, pork, onions	75.55	47.42	4.14	40.16	19.06		1.96		
Breakfast	Eggs, coffee	86.62	22.50	3.91	29.34	6.59	32.79	8.80	17.38	May 18, 1929
Dinner	*Bañgos*, tomatoes, meat, radish	81.12	29.83	13.79	53.85	16.08		4.12		
Supper	Fish, meat, tomatoes	68.06	48.07	9.07	23.37	10.12		4.36		
Breakfast	Egg, coffee	86.62	22.50	3.91	29.34	6.59	45.27	8.80	16.85	May 19, 1929
Dinner	Chicken, fish, sweet potato, *ubi*	54.94	76.84	3.25	42.44	32.20		2.50		
Supper	Chicken, fish	61.12	68.54	8.10	9.46	6.48		5.55		
Average	——	——	——	——	——	——	34.15	——	[illegible]	

EXCHANGE NOTES

Mention of oleomargarine in connection with the problems of the butter market, brings out an interesting question. Is not oleo made largely from animal fats produced in the feedlots of our own farms?

And is it not, therefore, just as much a farm product as butter?

The answer to this question reveals a change that has been going on for the last 10 years. Ten years ago animal fats constituted the largest source of ingredients for oleo. Today that is not true, coconut having come to the front as the most important single ingredient.

A little study of the following table, taken from the 1930 Year Book of the United States Department of Agriculture, will show that there has been a very decided change in the raw materials. With coconut oil now used in so much larger quantity, oleomargarine cannot be said to be a domestic product, and therefore is not entitled to the same consideration as butter, which is produced from our own soil.

Table showing ingredients used in manufacture of oleomargarine:

	1917	*1928*
Oleo oil	96,378,000	47,185,000
Coconut oil	61,773,000	171,412,000
Cottonseed oil	36,454,000	28,173,000
Milk	61,128,000	94,752,000
Peanut oil	21,593,000	6,617,000
Salt	18,279,000	27,311,000
Oleo stearine	3,427,000	5,834,000
Neutral lard	45,702,000	24,189,000
Oleo stock	7,526,000	1,294,000
Butter	4,548,000	2,611,000
Corn oil	60,000	———
Edible tallow	———	26,000
Mustard-seed oil	———	12,000
Coloring	———	47,000
Miscellaneous	14,000	1,474,000
Total	356,882,000	410,937,000

Note in above table how oleo oil, an animal fat, has decreased, and coconut oil, imported from the tropics, has increased.

—*The Prairie Farmer.*

The sale of rubber flooring has increased considerably this year; the Dutch rubber industry booked numerous orders, some of which were for several thousands of square meters.

—*The Planter.*

Thirty thousand acres of citrus and vines in Tulare County will be sulphured this spring by three airplanes now on nearby fields. . . .

—*California Cultivator.*

Increased utilization of soybeans in the last ten years has resulted in a rapid increase in acreage and production, and has advanced the crop to a position of major importance in American agriculture. . . .

The principal use of soybeans in the United States has been as a feed for live stock. Recently, however, attention has been given to the extraction of a valuable oil contained in the seed. Another use for soybeans in this country is as a human food. These beans have been utilized for many centuries by the people of oriental countries, and indications point to their wider use here as human food.

With the increased production of soybeans, definite knowledge of their feeding value for live stock was needed, and several of the State experiment stations conducted feeding tests with all kinds of live stock. Results of a number of these tests are summarized and included in a new publication of the U. S. Department of Agriculture, Farmers' Bulletin No. 1617-F, "Soybean Utilization."

—*The Aberdeen-Angus Journal.*

Ninety per cent of the population of Mysore live in villages. Agriculture is the only occupation of many of these. You (the panchayets) are their chosen leaders. Yours is therefore the opportunity to lead them in paths of progress and prosperity. You can do this work if only you have the will to do it. Here are a few hints to help you in your work:—

1. Introduce improved implements recommended by the Agricultural Department. . . . Better methods of cultivation alone have been found to bring about nearly 20 per cent increase in crop yields. Keep a small stock of these implements both for sale and for hiring out to raiyats [tenants.]

2. Help the raiyats to get good varieties of seeds. . . . Get the new varieties the Department is recommending. They are all superior to the local ones and give higher yields up to 30 per cent. Find out your requirements for the year and stock them for sale. Ask the advice of the nearest Agricultural Inspector in this connection.

3. Teach your neighbours better methods of collecting and conserving of cattle manure which will not only give you double the quantity but double the quality so that you increase the value of manure fourfold.

Popularize the use of artificial manures such as Sulphate of Ammonia and Superphosphate which have been found to be very valuable for our crops. It is possible to increase your crops by 50 per cent by judicious manuring.

4. Keep good cattle. A few good cattle do more work than a host of bad ones. The bad ones cost just as much to breed and feed as the good, and do only a quarter of the work.

Protect your cattle from disease by inoculation.

5. Co-öperate with the Department of Agriculture in its campaign against insect pests and plant diseases.—

6. Enrol yourselves as members of the Agricultural and Experimental Union, a semi-official body of persons interested in and working for the advancement of Mysore agriculture. Conduct the experiments planned out by the Union about the use of improved seeds, new manures or better methods of cultivation on your own fields so that they may serve as demonstration plots to the whole of your neighbourhood. Read the interesting articles on agricultural matters appearing in the Union Journal for the benefit of your raiyats.

—*Mysore Agricultural Calendar 1930* (India).

COLLEGE AND ALUMNI NOTES

On the evening of October 1, Dr. F. L. Stevens, Baker Memorial Professor, gave the fourth of his series of semi-popular lectures. The subject was "Significant topics regarding plant diseases". Under Doctor Stevens skillful handling, plant diseases had the interest of characters in a "best-seller" novel, even to the mystery phase.

A recent visitor to the College of Agriculture and the School of Forestry was Mr. N. Okazaki, Manager of the Formosa Pineapple Plantaton Co., Ltd., Takao, Formosa. Mr. Okazaki has had some years experience with pineapples also in Hawaii. He reports that the pineapples being grown in Bukidnon by the Philippine Packing Corporation are superior to those grown in Hawaii.

The Los Baños Biological Club held its monthly meeting on Thursday evening, September 25 in the Lecture Hall of the Department of Agricultural Chemistry.

The following papers were read and discussed:

1.—"About Philippine New Guinea 24-A and Barbados Canes" by Dr. N. B. Mendiola

2.—"Some tree-destroyers belonging to the Mistletoe family" by Ranger M. D. Sulit

The Mimics presented its second program of the college year in the Auditorium on the evening of September 20. Part I of the program was a home coming recital by Dr. Dionisio I. Aquino who recently returned from the United States where he had been studying soil technology as his major subject.

In his student days in the College Mr. Aquino gave much pleasure to Campus residents by his delightful violin solos. Needless to say his welcome in this recital was cordial and enthusiastic. It was evident from the technique and interpretation of each selection that Mr. Aquino had taken advantage of his years abroad to develop in music as well as in his chosen line. His old warmth of sympathy, much intensified, and his increased skill brought rounds of applause at the close of each number.

Professor Roa with his usual sympathy and appreciation accompanied the violinist.

The selections were:—

1.	Indian Love Call	*Rudolf Friml*
2.	Viennese Popular Song (The Old Refrain)	*Fritz Kreisler*
3.	Liebesfreud	*Fritz Kreisler*
4.	Rêve de Jeunesse (Dream of Youth)	*Felix Winternitz*
5.	Lelkem (Sweetheart)	*Oscar J. Lehner*

"Swing Low, Sweet Chariot", the old well loved negro "Spiritual", was sung by Miss Mamerta Manahan and Mr. Pedro Lorenzo.

The play presented by the Mimics was, "Love's Revenge, or The Woman Hater" by Tom Inglis Moore, Professor of English, College of Liberal Arts, U. P. The play is a bit of College life in Manila.

The cast, as in the last play, was remarkably well balanced. Miss Anne F. Cole, Director of Mimics, is to be commended for this desirable quality in the club plays. The women's part were played by men as in the first play given this year. These "fems" deserve all the panegyrics they have received as do the men who acted in men's parts.

The cast was:—

Juan (Engaged to Paz)	*Sabas Tangco*
Conrado Sales (The Woman Hater)	*Domingo Tugade*
Fidel Madarang (A Friend of Juan)	*Calo Bedelles*
A Student	*José Quintos*
María Villanueva (The Girl)	*Gabriel Flores*
Sabina (Maid)	*José Quintos*
Mrs. Villanueva (Mother of María)	*Onofre Casupang*
Paz (María's Friend)	*Marcelino B. García*

The U. P. R. H. S. sewing class helped Doctor Santos in making the Guest House ready. The class made the sheets and pillowcases, initialed them and the blankets and towels. This is the first year for a sewing course to be included in the high school curriculum. In the course, attention is given to the appearance of the completed article; correctness of style or its suitability; its usefulness; quality of work; and the interest which the girl shows in making the article. The course is intended to be not only practical but also educational.

More than 100 of the U. P. R. H. S. students and faculty spent Saturday, September 27, in Lucena, Tayabas. The round trip was made by special coach and every one reported a wonderful excursion, spending the time just "doing nothing in particular".

THE SIAMESE ROYAL SPRING PLOWING[1]

One of the oldest and most interesting of the royal ceremonies in Siam is the *Raak Na*, or plowing ceremony. De la Lonbère in his *Royaume de Siam* states that he believes the *Raak Na* had its origin in China, where it has been observed for five thousand years, and was brought into the country now called Siam at the time of the migration of the Lao-Tais southward. The Siamese ceremony, however, resembles that of India where it is seven thousand years old more closely than that of China. The *Raak Na* is Brahmin in form and Brahmin priests officiate although at times Buddhist priests are called on to take part in the ceremony.

This plowing ceremony has come down to the present in its original form except for a few minor changes. It has been held annually since written history began for the Siamese, with the exception of a few years before the middle of the nineteenth century. The *Raak Na* officially opens the plowing season. Until it has been performed the farmers will not begin work. This is not a law but a custom. The ceremony takes place some time around the first of May depending on the day appointed by the King on the advice of the Brahman priests.

Phya Thai Field, the place set aside for the annual observance of the *Raak Na,* is on the outskirts of Bangkok. It is a large field and the surrounding country gives the ceremony a rural setting.

The portion of Phya Thai Field actually used is not large. It is rectangular in shape. On entering the field one passes to the left of the Royal Pavilion. At the front and on each side, on the occasion of the *Raak Na* in May, 1930, there were some five-tiered white paper umbrellas. The Royal Pavilion is a permanent structure while the other pavilions are temporary. On the left of the ceremonial ground was the foreign colony pavilion; at the opposite side of the field and to the right of the Royal Pavilion was the pavilion for the priests; other parts of the field were roped off and chairs were supplied for the spectators. The Royal Pavilion was for the King or his representative, the royal family, and the wives of the princes.

The center of the Royal Pavilion is a raised platform on which the King and the most influential princes sit. Below on the level of the ground, but also in the pavilion, are the chairs for the other members of the Royal Family. When I arrived I noticed there were no women in the Royal Pavilion although the princesses are allowed to attend. The occupants appeared to be young men and boys. They were all dressed in blue, the official color, well creased *panungs*, white stiff jackets, women's hose and pumps. These royal young men seemed bored and tired of waiting. The guests in the foreign colony pavilion were also interesting. There were Englishmen, Frenchmen, Danes, Americans, and representatives of many other nationalities. Many had kodaks, and not a few had moving picture cameras. A Royal Prince, noted for his success with his moving picture camera, ran out on the field along with newspaper camera men and members of the foreign colony to take pictures of the procession. The pavilion for the priests was more or less a mystery to me as I did not enter it. But I saw yellow-robed Buddhist priests and white-robed Brahmin priests going in and out. Outside of the roped off sections were the most interesting people. They were from every class and every condition of life. These people were to take part in the most exciting part of the ceremony.

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[1] General contribution from the College of Agriculture No. 275.

The Ministry of Agriculture takes this opportunity to distribute pamphlets on agriculture. By the use of this ceremony the government hopes to awaken interest in agriculture and to show that its progress is essential to the prosperity of all classes. Although the educated Siamese do not believe in the portents and prophecies of the priests, the common farmer still retains his faith.

The ceremony itself is exceedingly interesting. Excitement begins with the arrival of the King, or his representative, either the Crown Prince or another very high ranking prince. As Rama VII was out of Bangkok in May, 1930, His Royal Highness Prince Nakon Sawan, the present Crown Prince, presided. The sirens sounded and every one stood erect. A yellow car drew up and out of it stepped His Royal Highness. Accompanied by other princes he walked to the Royal Pavilion and ascended the platform. When he was seated every one else sat down.

Immediately after the arrival of the Crown Prince the procession formed. First came the musicians dressed in ancient costumes, playing a weird tune on ancient instruments. Then came the Minister of Agriculture who is appointed by the King to do the actual plowing. He wore a gorgeous robe of gold cloth and a many-tiered crown. After him came the white-robed Brahmin priests who carried the sacred conch shells some of which were filled with holy water while others were blown at intervals by the priests. They give a very weird note. The musicians were followed by Brahmin priests who preceded the Minister of Agriculture. Then came more priests, and the plow, pulled by the attendants. The plow is a beautiful, graceful, slender implement with one handle. The frame work is of wood covered with gold leaf. The implement is about five meters in length and of primitive design not unlike that of the Philippine plow. The long, graceful beam is high. It curves in an upward sweep so that when the oxen are hitched to the plow the beam is even with their necks and the end curves downward. The plow has one share of ordinary size and at the back of it is a handle almost shoulder high that is used for guiding the plow. This same plow has been used for many years. When it is not in use it is in the Royal Museum, where also can be seen the robe and crown of the official who performs the plowing ceremony.

The procession entered the field to the left of the Royal Pavilion, went down the field past the foreign colony pavilion, turned and proceeded to the pavilion for the priests where it stopped. The Minister of Agriculture and the priests entered the pavilion where the Minister knelt before an altar and prayed, after which he chose a skirt from three offered him. The choice of the skirt is very important, and the choice is anxiously awaited by the people. If the skirt is a short one there will be a drought the coming year, and if it is a long one floods can be expected. But if the skirt chosen is medium in length, as it was at the ceremony I saw, then normal rains are the prospect. The Minister of Agriculture donned the skirt and left the pavilion to continue the ceremony.

The procession then went on to the Royal Pavilion. After the procession left the Priests' Pavilion four beautiful, glossy, tawny oxen were led on to the field and tied in a covered stall erected for the purpose.

On reaching the Royal Pavilion, the procession stopped. The Minister of Agriculture advanced to a position immediately in front of the Crown Prince where a mat had been placed. Here he knelt, placed his hands together in an attitude of prayer, described a small circle three times, then bowed low. This obeisance was repeated three times.

After this ceremony two of the four oxen were led out and hitched to the plow. At the head of each ox walked a green-robed attendant. The Minister of Agriculture now walked behind the plow. He placed his hand on the handle but did not do any of the actual work. The work was done by an attendant who in a stooping position pressed the plow into the earth. This was not very difficult as the ground had been previously plowed and harrowed. Some of the Brahmin priests now ranged themselves alongside the oxen and behind the plow.

After three furrows were plowed around the field four very old women of noble rank, each carrying two baskets suspended from a bamboo stick, Chinese fashion, took their places behind the Minister of Agriculture. In the baskets were seeds. As the procession proceeded the Minister called a halt from time to time and broadcasted the seeds from the baskets of the old ladies. The Brahmin priests at intervals would shake water from the conch shells they carried. This proceeding continued until the field was plowed, all the seeds scattered, and all the water sprinkled.

When the procession withdrew from the field many Siamese ran on to the field to pick up the seed. They were driven back by the guards as the time for this had not yet arrived.

The oxen were unhitched from the plow and led in front of the Royal Pavilion where two plates of grain and vessels of water and wine had been placed for them. What the oxen eat is of great importance as it foretells the crop yield for the coming year. On this occasion the oxen were rather perverse and it was some time before they would deign to eat anything. But the priests were ready for any contingency and when the portents gathered from the ceremony were announced to the public it was prophesied that the main crops of Siam were to be normal in yield and one very minor crop was to be poor.

After the oxen had eaten or rather had failed to eat, the most interesting spectacle occurred. The populace broke through the rope and ran on to the field. Men, women, children, the wealthy, the poor, the farmer, the merchant, the student, the office holder all were eager to pick up some of the seed that had been broadcast. It is the belief that even one grain from the field, if mixed with the grain to be used for planting, will bless the crop and increase the yield.

This plowing ceremony is observed at central places in the kingdom on the same day as the ceremony is performed in Bangkok. The King appoints officials to represent him in the outlying districts. Thus Siam is trying to use one of her oldest ceremonials as an agency in awakening interest in and distributing information about her most important industry, agriculture.

Anne F. Cole,
Of the Department of English.

Let no youth have any anxiety about the upshot of his education whatever the line of it may be. If he keeps faithfully busy each hour of the working day, he may safely leave the final result to itself. He may with perfect certainty count on waking up some fine morning, to find himself one of the competent ones of his generation, in whatever pursuit he may have singled out. Silently, between all the details of his business, the power of judging in all that class of matter will have built itself up within him as a possession that will not pass away. Young people should know this truth in advance. The ignorance of it has probably engendered more discouragement and faint-heartedness in youth embarking on arduous careers than all other causes put together.—*William James.*

—From Dean Baker's Scrapbook.

"There are thousands to tell you it cannot be done,
There are thousands to prophesy failure,
There are thousands to point out to you one by one
The dangers that wait to assail you.
But just buckle in with a bit of a grin,
Just take off your coat and go to it;
Just start in to sing as you tackle the thing
That cannot be done—and you'll do it!"

—*The Prairie Farmer.*

FURTHER OBSERVATIONS REGARDING ULTRA-VIOLET IRRADIATION AND PERITHECIAL DEVELOPMENT[1]

F. L. STEVENS

Professor of Plant Pathology, University of Illinois, Urbana, Charles Fuller Baker Memorial Professor (1930-1931 of Plant Pathology), University of the Philippines

WITH SIX TEXT FIGURES

DEVELOPMENT OF THE PERITHECIUM

The story of the development of a perithecium without irradiation is difficult to follow, since such perithecia occur so rarely, in such small numbers, and at no predictable time, that nothing is known of it. With suitable strains of fungus, as G 10-15[2], about fifteen perithecia per square millimeter of agar plate can be called into being in a few hours and more progress in this study can be made.

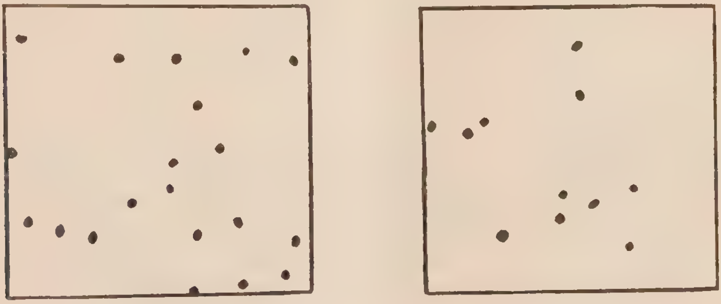

Fig. 1.—Two square millimeter areas, enlarged, showing typical frequency of perithecia 30 hours after irradiation.

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[1] Other articles by the author regarding the ultra-violet irradiation of fungi are as follows:

1. Stevens, F. L. 1928. The sexual stage of fungi induced by ultra-violet rays. Science n. s. **67**: 514–515.
2. Stevens, F. L. 1928. Effects of ultra-violet radiation on various fungi. Botanical Gazette **86**: 210–225.
3. Stevens, F. L. 1930. The response to ultra-violet irradiation shown by various races of *Glomerella cingulata*. Amer. Jour. Bot. **17**: 870-881. *Fig. 1-6.*
4. Stevens, F. L. 1930. The ascigerous stage of *Colletotrichum lagenarium* induced by ultra-violet irradiation. Mycologia. In press.
5. Stevens, F. L. 1930. The effects of ultra-violet irradiation on various Ascomycetes, etc. Centralblatt. f. Bakt., etc. In press.
6. Stevens, F. L. 1930. Relation of nutrients to perithecial production under ultra-violet irradiation. The Philippine Agriculturist **19**: 265–272. *Fig. 1–3.*

[2] A strain of *Glomerella cingulata* which produced perithecia when irradiated and only then.

In order to study the development of perithecia induced by irradiation a sterile cover glass 42 cm. square and of No. 2 thickness was placed in a sterile petri dish and over it was poured 10 cc. of corn meal agar. When the agar was solidified it was inoculated with G 10-15 along one edge of the buried cover glass and about five millimeters from the edge of the cover glass. In three to four days the mycelium had grown out over the cover glass to a distance of 2.0 or 2.5 cm. The plate was then irradiated for 30 seconds. Then the cover glass with its agar and fungus was cut out, removed, and inverted over a glass ring, 4 cm. in diameter and 1 cm. high, forming the usual van Tieghem cell sealed by vaseline and with water in the bottom of the cell. The cover glass was then ruled with India ink on the upper side into millimeter squares. The object of all this was to enable repeated observations of given definite areas with the high power of the microscope, such observations being impossible through the thick bottom of the petri dish.

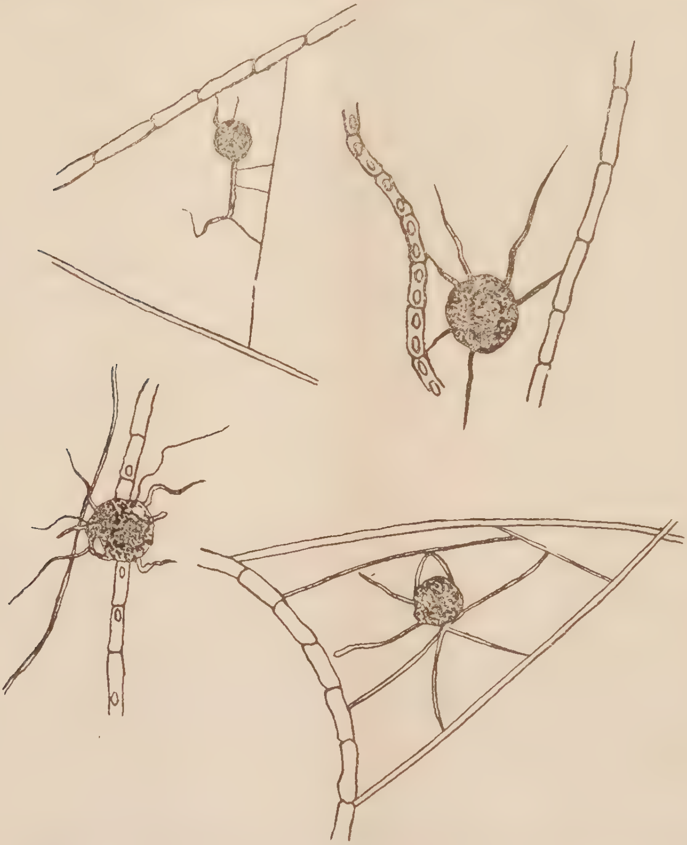

Fig. 2.—Showing perithecia of G 10-15 originating on plexi of fine mycelium between coarser mycelium, also originating on a coarse filament.

By means of the method outlined above, which enables one to follow the development of single perithecia, the following account may be given:

At 24 hours perithecia were definitely recognizable as hyaline spherical bodies. At 36 hours after irradiation the perithecia were well defined, about 18 μ in diameter and globose, with a distinct cortical development though still hyaline. At 56 hours, when about 30-40 μ in diameter, the perithecia began to darken and to show distinct reticulations. When mature they attained even 200 μ in diameter and the surface was irregularly reticulate, the meshes being about 3-5 μ across.

Within a given millimeter square one perithecium first appeared and this was followed by others until about 30 hours after irradiation when the development of new perithecia ceased. Typical spotting of the squares with perithecia at 30 hours after irradiation is shown in figure 1.

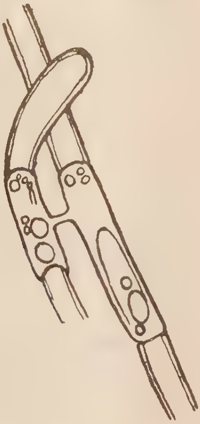

Fig. 3.—Anastomosis or possibly fertilization.

The development from the initial stage to that of the globose, well defined perithecia is naturally much more difficult to follow. In both irradiated and non-irradiated regions there were two types of mycelium; one coarse, 11 μ thick, the other thin, 3 μ, both guttulate. The study of irradiated plates showed that perithecia are borne among these mycelia in two ways:

1. They originate in a plexus composed of a few of the finer threads of mycelium meeting between two or more strands of the coarser mycelium (fig. 2).

2. They appear sometimes to arise from one or more cells of the coarse mycelium without intervention of the fine mycelium (fig. 2).

No actual evidence of fertilization has yet been seen, though suggestions of a union as in figure 3 are met. Microtome sections of perithecia 16 hours after irradiation show the enveloping layer of the perithecium to be one cell thick (fig. 4), but other details were not made out.

Perithecia induced by a dosage weak enough to permit their formation on the surface of the agar, rather than buried in it, were covered with a loose growth of fine mycelial threads, while perithecia induced by greater dosage and therefore buried in the agar did not show this character.

DOSAGE FOR PERITHECIAL PRODUCTION

Plate cultures of susceptible age were irradiated for various times and with various wattage to determine the relation of the minimum time and current to perithecial formation. Since the formation of perithecia within the agar involved also the problem of the absorption of the rays by the agar the study was based entirely upon the formation of perithecia upon the surface of the irradiated plates.

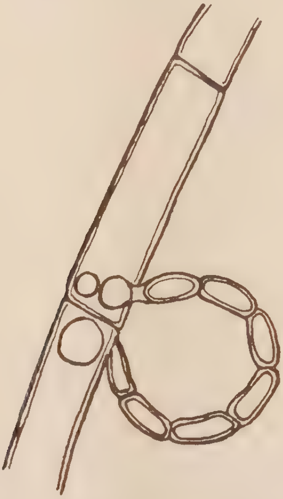

Fig. 4.—Section of a perithecium 16 hours after irradiation showing the perithecial wall one cell thick.

Forty-eight hours after irradiation, perithecia if formed are easily recognized by the unaided eye and verified through the microscope. The perithecial response is usually abundantly attested, scores of perithecia being visible in a low power microscope field. Such a response was considered as positive and normal and all graphs were based on such responses. The few instances where a single perithecium, or very few perithecia, were found on the irradiated part of the plate were ignored. Such isolated perithecia perhaps indicate special susceptibility of single cells or an intensification of current energy at this point. The observed and the theoretical curves are given in figure 5, B and C, and figure 6, B.

The exposure necessary to kill spores (conidia) is also shown graphically in figures 5 and 6. The determinations were made by placing a spore suspension in a drop of water on top of solidified agar. A few moments were allowed to elapse so that the water might evaporate. Exposure was then made for various times and wattage. It was found that with increase of dosage a degree was reached at which less than half of the spores germinated, instead of the normal one hundred per cent, and these but slowly. Further increase of dosage beyond this point reduced both the percentage and vigor of germination till eventually a dosage was reached where perhaps less than

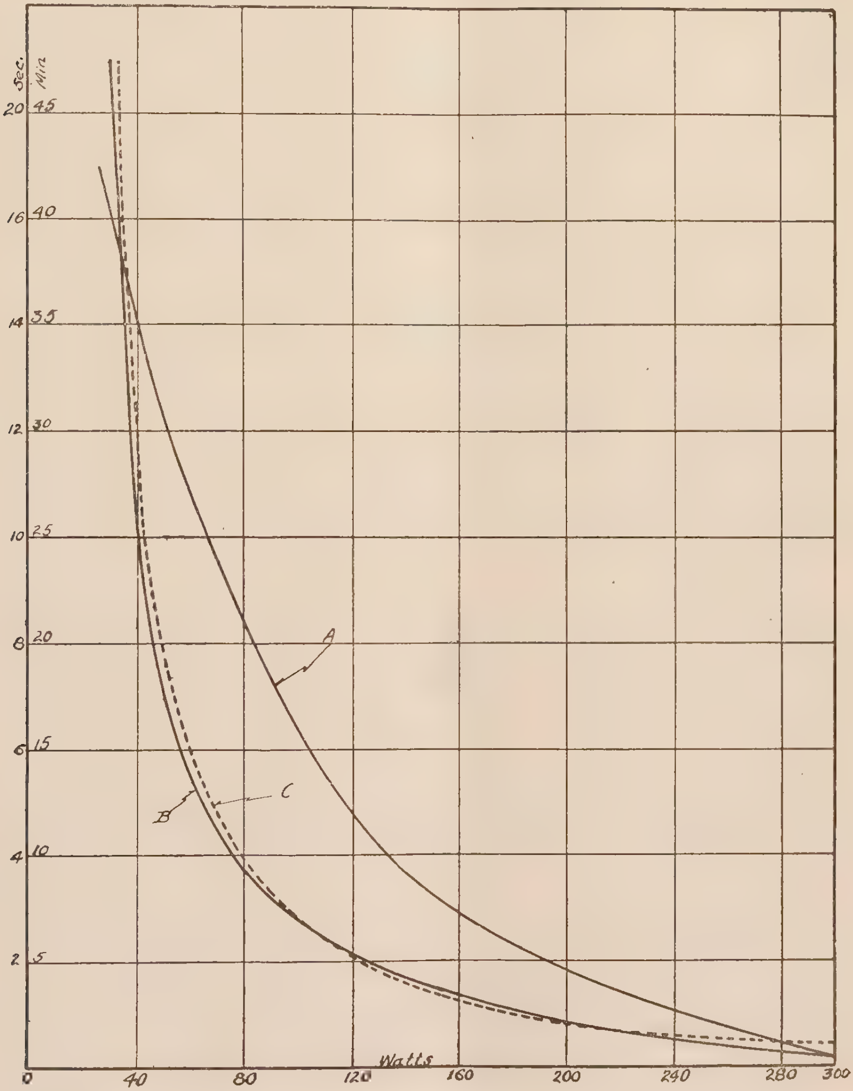

Fig. 5.—(*A*) Lethal curve for spores based on partial killing, giving minutes and watts. (*B*) Perithecial curve showing seconds and watts. Solid line test curve. (*C*) The theoretical curve.

one per cent of the spores grew. Evidently single spores in a drop, due perhaps to the stage of maturity, were much more resistant to irradiation than were the other spores. Thus, for example, it was found that with 75 watts most of the spores were inhibited by 23 minutes exposure, still there was some germination at 42 minutes.

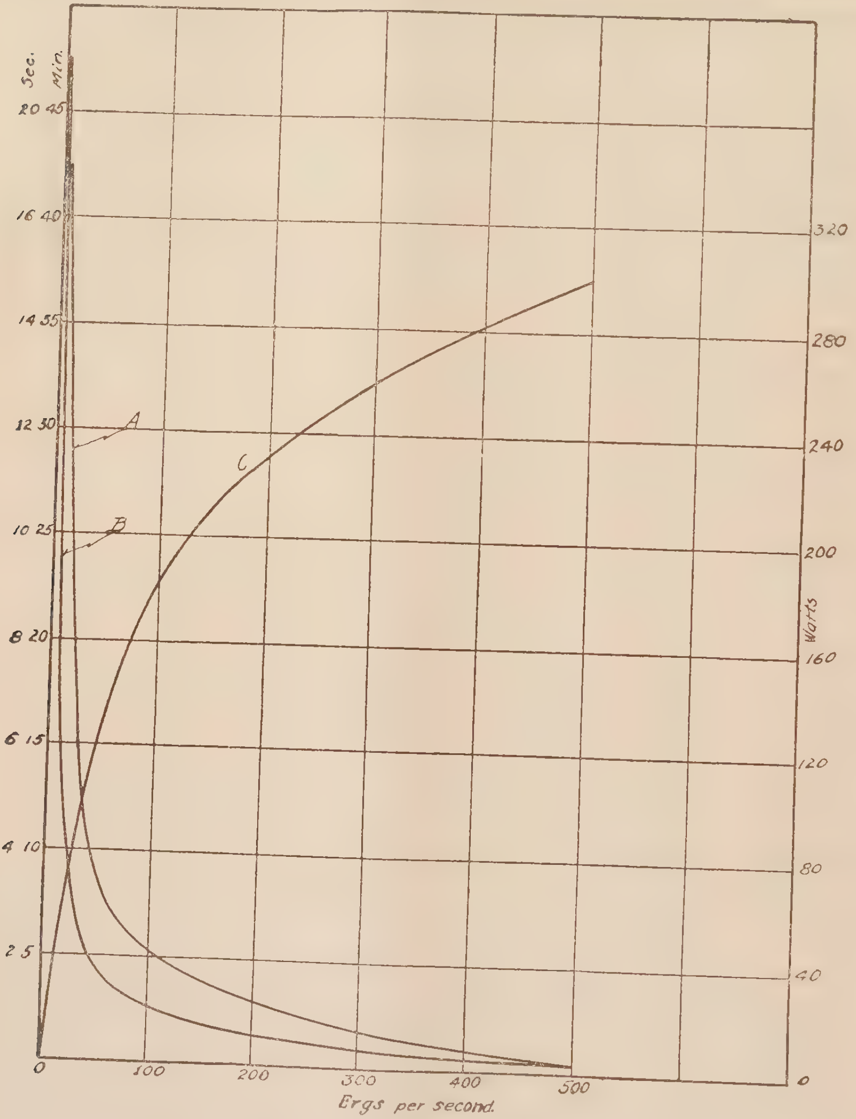

Fig. 6.—(*A*) Lethal curve for spores based on partial killing giving minutes and ergs. (*B*) Perithecial curve showing seconds and ergs. (*C*) Curve showing output in ergs with various wattage, as indicated by use of the Gordon meter.

A similar condition was reported by Fulton and Coblentz (1929) who state that "the only complete kill obtained was with an exposure ten times as long and an intensity almost four times as great as was required to kill 9,999 out of 10,000 spores",. . :"It is to be noted that the more resistant fungi, as a group, are the ones having dark spore walls".

They state as explanation of this that "The main reason for the erratic survival of a relatively small number of spores after exposure for excessively long periods of irradiation is presumed to be the clumping of the *Penicillium* spores in such a way as to shade some from the rays." Such explanation will not apply here since there was no such clumping.

Occasionally *Alternaria* spores, which are dark colored, were irradiated together with *Glomerella* conidia and, though no determination of the lethal point was made for *Alternaria*, it was quite evident that the *Alternaria* spores withstood considerably longer irradiation than did those of *Glomerella*.

Comparing the lethal dosage, as here defined, it is seen that dosages approximately 300 times longer were required to kill conidia than were needed to induce perithecia even in the limited sense in which the lethal point is here interpreted.

Colony stunting is so difficult to recognize accurately that it is not possible to determine the dosage required. The energy required for colony stunting clearly is, however, considerably lower than that of the lethal point for spores.

In the instance of a comparatively few species of fungi the sexual stage is borne freely and abundantly along with the conidial stage, but in the great majority of cases the conidial stage only is seen abundantly and the ascigerous stage is seen only rarely or has never been seen. Thus we have that great group of fungi, the Fungi Imperfecti, consisting of many thousands of species of conidial forms only. Many attempts have been made to secure the perithecia appertaining to these conidial forms. In a very few instances these attempts have succeeded; a condition has been hit upon which results in the development of the sexual stage; in the vast majority of cases attempts have failed.

Aside from these species that in nature always form the sexual stage there are others in which sexual strains and non-sexual strains occur. Some, perhaps many, fungi are heterothallic and the securing of the sexual response, of course, depends upon bringing together the proper strains. Many forms are, however, homothallic since the sexual stage arises in cultures of monosporous origin.

No generalization has been made as to why the conidial stage gives way to the sexual stage in some instances and not in others. Very diverse conditions have been reported as leading to sexual response. A few are cited here.

Miss McCormick (1925) reports that though *Thielavia basicola* sometimes forms perithecia when alone it is greatly stimulated in perithecial production by the presence of *Thielaviopsis basicola, Cladosporium fulvum, Aspergillus umbrosus, Eurotium amstelodami* and *Fusicladium pirinum.* Unautoclaved water extracts of some of these and of other fungi as well also stimulated perithecial formation though autoclaved extracts did not do so.

Molliard (1903 a, b) states that *Ascobolus* produces perithecia when certain bacteria are present in the cultures.

Sartory (1916, 1918, 1920) cites the production of perithecia of *Aspergillus* under the influence of a bacterium and thinks that this occurs because of chemical changes induced in the medium by the bacterium. He also has cited sporulation of yeast, *Willia*, under the influence of bacteria, (Sartory, 1912), and says that association is needed for production of ascospores in yeast and *Aspergillus.*

Sartory, Sartory, and Meyer (1926) report that *Aspergillus fumigatus* under action of radium, and on media of very special composition only, bears perithecia.

Wilson (1927) noted that the perithecia of *Venturia* were larger and more numerous near colonies of certain fungi and that a sterile, unautoclaved water extract of a *Penicillium* applied to cultures also increased both number and size of the perithecia while a similar autoclaved extract also did so, but to much less degree.

Heald and Pool (1909) state that *Melanospora* produced perithecia when grown with *Fusarium moniliforme* or *Basisporium gallarum.*

Shear and Wood (1907, 1913) who studied many strains of anthracnoses say, "We have been unable as yet to tell definitely what the factors are which control the production of the ascigerous form". "Repeated experiments with various culture media, under various conditions of light, temperature, and moisture, seem to indicate that these are no factors of great importance," stating that the chief factor in securing perithecia is the race employed.

The classic researches of Klebs (1898, 1900) demonstrated that in certain homothallic fungi, e. g. *Sporodinia* and *Saprolegonia*, the type of sporulation, whether conidial or sexual, was dependent upon the nutritive condition and humidity and he was able to produce at will the spore form desired. In general, luxuriant growth, followed by a sudden restriction of growth, led to the development of the sexual stage.

In my own researches it is observed that a very common, though not universal, effect of irradiation is to increase sexual or asexual production if such occurs normally and in some species to induce the sexual stage where it does not occur normally.

On irradiation certain cells only or certain groups of cells respond. It is roughly estimated that even less than one cell in 500 so responds. Also it appears that cells in certain zone ages respond in some strains though not the same zone ages respond in other strains. The fact that groups of perithecia form in response to irradiation in a zone of certain age, but that such groups are not produced throughout this zone shows that there are individual cell differences not due to age alone that render perithecial response by them to irradiation possible. A second crop of perithecia often appeared near by those first induced; this may be due to a lag in the original direct stimulation or it may be due to a secondary effect arising from the adjacent group of perithecia. If so this may indicate a transfer of stimulus from cells that responded to irradiation to cells that did not so respond.

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COAL TAR-KEROSENE EMULSION AND ITS USES AS AN INSECTICIDE[1]

J.M.R

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While conducting experiments in dipping sugar-cane points for the control of seed-borne insects and of pests of very young plant canes, the writer, in tests which included a number of standard insecticides and their combinations, finally narrowed down to an emulsion containing coal tar, kerosene, and ordinary laundry soap dissolved in water. The idea underlying the choice of these ingredients was to combine the insect-repelling qualities of coal tar with the insecticidal properties of kerosene in a form that would be innocuous to certain forms of plant tissues. Moreover, coal tar, unless previously diluted with kerosene, cannot be worked into an emulsion. No credit is, of course, claimed for originating the use of any of these substances, for coal tar has long been employed in coating ends of plant cuttings and dressing wounds in trunks and branches of trees, while kerosene emulsion is an old-established, standard insecticide.

Repeated trials with coal tar-kerosene emulsion in our controlled experiments gave highly gratifying results. It was found to be efficient not only in killing mealybugs and other insects that ordinarily are hard to reach between the leaf sheaths and the cane stem but also in effectively protecting cut ends of the mother plants and the eyes and developing shoots from attacks by termites and other ground-inhabiting insects. A detailed report on the results of these experiments will be given in a separate paper. The following notes on other applications of the insecticide than those embodied in our main dipping experiments are given in the hope that they may be of some use to those who are confronted with similar problems.

PREPARATION OF THE EMULSION

Stock solution

Laundry soap	500 grams as
Coal tar, or "alquitran" (without creosote)	5 liters
Kerosene	3 liters
Water	4 liters

Shave soap into water and boil until dissolved. Remove mixture from fire, and, while still hot, gradually add to it kerosene and coal tar which have been previously mixed in a separate container. As this is added, beat briskly with a small branch with many twigs until a fairly complete emulsion is formed, as may be judged by the mixture upon standing for a short while becoming almost homogeneously whitish brown, without any floating film of kerosene and coal tar.

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[1] Experiment station contribution No. 691. Received for publication October 20, 1930.

For use, take one part by volume of stock solution and dilute with five to ten parts of water.

USES OF THE EMULSION

In addition to dipping sugar-cane points, for which a one-to-ten dilution was used, subsequent trials indicated that the emulsion had a much wider range of application than that for which it had been originally intended. In the Philippines, where, even in cities, arsenicals and other widely accepted insecticides are frequently not readily available, there is an obvious advantage, other things being equal, in resorting to substances which may be easily purchased in practically any village store. Kerosene, which is sold almost everywhere in the Islands as an illuminant and for other purposes, coal tar, or *alquitran*, which is of general use as a protective paint, and laundry soap are not difficult to secure in quantities in the vicinity of farming communities. These ingredients, moreover, are relatively cheap. These two factors primarily give the emulsion promise of wide acceptance in this country for the various uses stipulated below. It is, of course, needless to point out that an emulsion, such as this, should not be applied on foliage, which is likely to be scorched, with a resulting more or less serious damage to the plant. Another precaution which must be emphasized is that if the emulsion is to come in direct contact with plant tissues, as in the case of dipping seeds and stem cuttings, care must be taken that the coal tar does not contain any creosote. There are certain manufacturers who mix creosote with coal tar to meet various special trade demands, and occasionally this product is sold indiscriminately as *alquitran*. Creosote in the mixture has been found to prove fatal to sugar-cane points.[3]

Control of white grubs in sugar-cane fields. The writer published a brief description of the method in May, 1930 (Uichanco, 1930), to which the reader is referred. A one-to-five dilution is used. The practice of corralling the grubs of *Leucopholis irrorata* Chevrolat with emulsion-treated trench at the time of initial appearance of infestation in the sugar-cane field, has been found to give absolute control in our experiments. The cost of the treatment (material and labor) has been found in our experimental field of about two hectares to be a little over six pesos. The method will probably work also for other forms of white grubs in the sugar-cane field, such as *Lepidiota*, *Anomala*, and *Holotrichia*, which, like *Leucopholis*, remain concentrated in small patches in the field during the earlier larval instars. The emulsion has been noted to remain in effective form among the soil particles in the trench for as long as three months—a sufficient length of time to enable the plants to attain enough maturity for harvesting.

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[3] The writer is indebted to Dr. M. L. Roxas, director of the Bureau of Plant Industry, for the report of his experience with this substance at the Pampanga Sugar Mills while he was still connected with the Philippine Sugar Association.

Control of bark borers in fruit and shade trees. Early in 1929, Mr. L. Weinzheimer requested the writer's co-operation in the control of the mango bark borer, *Plocaederus ruficornis* Newm. (Cerambycidae, Coleoptera), which was causing considerable injury on the mango trees at the Calamba Sugar Estate, Canlubang, Laguna. The period from February 18 to March 13, 1929, was spent in excising dead tissues resulting from the work of the borer and painting the whole of each trunk and larger branches with a one-to-five dilution of coal tar-kerosene emulsion. The appearance of a gummy secretion at the bark, the accompanying accumulation of trash, and the dark, watery appearance of the affected bark area were invariably telltale signs of earlier infestation. In advanced cases the branches affected completely died off, and the whole tree was eventually killed in very severe attacks. As previously pointed out by Jones (1913), the damage is caused by the combined work of a number of grubs living together. Biological notes, including habits of this species, are also given by this author. Our investigations have confirmed his findings that only trees which were about ten years old or over were subject to infestation by this pest.

In the present work, care was taken to remove and destroy the grubs during the process of cleaning out the dead plant tissues. Painting was done soon after the surgical operation, in order to eliminate chances of fresh reinfestation in the unprotected raw wounds in the trunks and branches. The writer is indebted to the authorities of the Calamba Sugar Estate for their generous co-operation and to Mr. R. Suero, technical assistant of the company, for helping carry out the experiments. The cost of this first treatment was as follows. The expense item for labor includes the salary of the overseer.

Labor	
Excising dead tissues from trees and picking out grubs	₱17.30
Painting with coal tar-kerosene emulsion	25.84
Total for labor	₱43.14
Material	
5 gallons coal tar	₱ 1.40
4.5 gallons kerosene	2.48
Laundry soap	1.12
Total for material	₱ 5.00
Expenses for labor plus material	₱48.14
Number of mango trees treated	65
Average cost of material per tree	₱ 0.077
Average cost of labor per tree	0.664
Average total expenses per tree	0.741

The largest item in the expenses was in labor used in painting with emulsion, which amounted to 53.7 per cent of the total. This was due to the fact that no spray pumps were available for this work at the time, and the treatment had to be done promptly in order to save the trees, so that we could not wait for the equipment ordered for that purpose.

The trees were inspected from time to time for recurrence of infestation. In June, 1930, nine trees were showing signs of fresh attack. Treatment of the sixty-five trees was repeated on June 11, 12, and 16. The cost for this second treatment was as follows:

Labor	₱4.82
Material	
Coal tar	1.44
Kerosene	2.04
Soap	0.32
Total expenses for material	₱3.80
Average cost of material per tree	0.058
Average cost of labor per tree	0.074
Average total expenses per tree	0.132

A considerable saving was effected in this last treatment owing to the fact that only nine trees had to be cleaned out and also that this time spray pumps were used.

Although the present work has not been done on a sufficiently large scale for definite conclusion, indications are that the treatment if repeated at least once a year provides the mango trees ample protection against *Plocaederus* attack.

Likewise, other kinds of trees which are subject to the attack of various species of bark borers, as the cacao[3], would probably respond to this treatment favorably.

Control of ants in seed beds. Only very preliminary experiments have so far been tried in connection with the treatment of seeds or seed beds to ward off ants. It is intended to make this matter a subject for more extensive investigation. However, such fragmentary results as have been obtained indicate that if seeds are previously immersed for a few minutes in a one-to-ten dilution of the emulsion and then drained on a piece of cloth immediately before planting they are not subject to the ravages of ants. The practice would especially be useful in the case of seeds of tobacco, papaya, and tomato and other vegetables in which the ants are quite a serious problem.

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[3] The worst species of Cerambycid bark borers of cacao in the Philippines are *Praonetha bigibbera* Newm., *Euclea capito* Pascoe, *E. albata* Newm., and *Sthenias varius* Olivier. They are widely distributed in the Archipelago and undoubtedly one of the main causes of failure in attempts at establishing cacao plantations in this country on a worth while commercial scale is due to the destructiveness of these pests. The two foregoing species of *Euclea* have also been recorded on mango and on avocado.

Preventing termite damage on woody cuttings. Cuttings of ornamental shrubs, such as *Codiaeum*, *Acalypha*, *Graptophyllum*, etc., and of certain fruit trees very frequently fail to take root, owing to the fact that termites eat away the portions buried in the soil. Immersion of entire cuttings for a short time in a one-to-ten dilution of the emulsion, as in the case of sugar-cane points, has been found to prevent damage from this pest and apparently does not affect germination.

Control of cattle foot maggot, or "kayuko." No experiment has been carried out by the writer along this line, but Dr. M. L. Roxas has reported successful control of foot maggots with his dairy cattle in Lipa, Batangas, through the use of this insecticide. The affected hoofs were immersed in a one-to-five dilution of the emulsion, after the maggots had been cleaned out. This is another promising field for application of this insecticide, inasmuch as that malady is quite common on cattle, carabao, goats, and probably other species of Bovidae in the Philippines. The cause is the larva of a muscoid fly, the occurrence of which was recorded for the first time in 1922 (Woodworth and Ashcraft, 1922), and the species described in the same year as *Booponus intonsus* Aldrich (Aldrich, 1922). The former authors also mentioned a screw worm, *Compsomyia dux* Escholtz, "a very common and harmful pest of stock in the Philippines." Incidentally, it may be of interest to note in passing that the latter species was apparently incorrectly identified, for specimens of these screw worms sent by the writer to Major W. S. Patton, of Trinity, Edinburgh, were determined by him as *Chrysomyia bezziana*, which, according to this authority, "is widely distributed in the Oriental Region." Woodworth and Ashcraft used, largely, chloroform packs against these pests. Possibly dipping in coal tar-kerosene emulsion would be simpler and less difficult of execution even in the hands of a non-veterinarian. Likewise, prophylactic treatment with this mixture at regular intervals may be advisable, especially during the dry season when infestation is much more common than during the rainy months.

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A BACTERIOLOGICAL ANALYSIS OF THE LOS BAÑOS COLLEGES WATER SUPPLY WITH SPECIAL REFERENCE TO ITS POTABILITY[1]

ZACARIAS DE JESUS
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WITH ONE CHART

Many people living on and near the College Campus believe that the Los Baños Colleges water supply is safe to drink because it comes from a river in the virgin forest of Mount Maquiling. The water from the faucets is, as a rule, turbid and dirty when there is much rain, at other times it is clear and clean. Many drink this tap water so long as it is clear and colorless.

Favorable physical characteristics of a surface water, such as clearness, lack of odor and color, and palatability do not constitute an index of its potability. A complete bacteriological examination is necessary before a river water can be considered as safe to drink.

Since the Los Baños Colleges water supply is a river water and is not chlorinated or otherwise treated to destroy its bacterial content it was deemed important that it be analyzed bacteriologically to determine its sanitary quality. The experiments were performed in the Bacteriological Laboratory of this college with the advice of Dr. A. K. Gomez, Head of the Department of Pathology and Bacteriology.

The main object of the present study was to determine whether or not the Los Baños Colleges water supply is safe to drink, and the secondary object was to prove the fallacy of the colon presumptive test for a river or surface water.

MATERIALS AND METHODS

The sample of water was collected from the water main and from the faucets. For containers several 250 cc. Erlenmeyer flasks were plugged with cotton and sterilized in the autoclave at 20 pounds pressure for 20 minutes. An enameled dipper was wrapped in paper and was also sterilized in the autoclave. Standard 1 cc. pipettes and Petri dishes were wrapped in paper and sterilized in the hot-air sterilizer at 160°C. for one hour.

The samples from the water main were collected through the openings of the concrete boxes with a sterile dipper and placed immediately in sterile

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flasks. The samples from the faucets were collected directly into sterile flasks after the water had been allowed to flow freely for at least three minutes. The amount of each sample collected was between 150 and 200 cc. The tests were performed one hour after the collection of the samples.

The technique employed in the quantitative and qualitative analyses, except with slight modifications, was in accordance with the recommendations of the Committee on Standard Methods of the American Public Health Association. Since the hydrogen ion concentration of the water was pH 7.8, the reaction of the nutrient agar used was brought down to pH 7.0. Owing to lack of facilities, nutrient gelatin could not be employed in the quantitative analysis. The omission of gelatin plates, however, would not materially affect the results as they are only of comparative importance in case the water examined is contaminated with sewage. In the qualitative analysis an effort was made to identify several lactose-fermenting bacteria isolated from the water and suspected to be of fecal origin.

Fresh leaves of plants from branches that were from one to two meters above the ground or rocks and hanging over Molawin Falls on Mount Maquiling and the intake were gathered. Each leaf was held with a sterile pair of forceps and cut off with a sterile pair of scissors. Without touching the leaf with the fingers, it was wrapped up in a piece of sterile paper.

EXPERIMENTS AND RESULTS

Experiment 1. On the determination of the number of bacteria per cc. of the water. The sample of water was diluted in sterile tubes to 1:20, 1:50, 1:100 and 1:200. One cc. of each dilution was placed in a sterile Petri dish and to this was added 10 cc. of melted nutrient agar at a temperature of 40°C. The medium and water were mixed thoroughly by tipping the Petri dish back and forth and then allowing the contents to spread uniformly. The plate cultures were kept at room temperature of from 28.5°C. to 29.0°C. for 48 hours. Counts were made only on plate cultures showing more than 25 and less than 200 colonies. So far as practicable the colonies were counted one by one. If the colonies were quite numerous in the plate they were counted with the aid of Wolffhugel's counting apparatus.

Bacterial counts were made of the samples collected on rainy days soon after heavy rain when the water was turbid and dirty, and on sunny days when the water was clear and clean. The bacterial counts are shown in table 1. The averages of the counts of the different samples collected under different weather conditions were plotted as a graph (chart 1).

Experiment 2. Colon presumptive tests. As prescribed by the Standard Methods, five 60 cc. Smith fermentation tubes of lactose broth were each inoculated with 10 cc. of an undiluted sample. Several Durham fermentation tubes of lactose broth were inoculated with quantities of a sample varying in amounts from 1 cc. to 0.0001 cc. The cultures were incubated at 37°C. for 24 hours. The results are shown in table 2.

Experiment 3. On the determination of a probable source of the lactose-fermenting bacteria in the water. A small piece, about 2.5 centimeters square, was cut off with a sterile pair of scissors from each leaf collected as noted under "materials". With the aid of a sterile pair of forceps and a stiff inoculating needle this piece of a leaf was introduced into the bottom of a Durham fermentation tube of lactose bouillon. After thoroughly immersing it in the medium it was removed and discarded. The inoculated tubes were incubated at 37°C. for 24 hours. The results are shown in table 3.

Experiment 4. Partially confirmed tests. The presumptive tests were partially confirmed by inoculating twelve Petri dishes containing Endo medium. The plate cultures were incubated at 37°C. for 24 hours. Typical vermillion red colonies, which apparently simulate those of *Escherichia coli*, were fished out and subcultured on nutrient agar slants. Thirteen cultures were made from 12 Endo plates (see table 4). Each culture was examined for its morphological and staining characteristics.

Experiment 5. Completed tests. Each culture of the bacteria was inoculated into a Durham tube of lactose broth. The cultures that produced both acid and gas were again examined for their morphological and staining characteristics. The culture of bacteria that were found to be motile, Gram-negative and non-spore-bearing were grown on eosin-methylene-blue lactose agar plate, to demonstrate the characteristic growth of the colon bacillus to determine if these cultures were of *Escherichia coli*. The results are shown in tables 4 and 5.

Experiment 6. On the identification of the coli-like bacteria isolated from the water. Each of these bacteria having the morphologic and staining characters which correspond to those of the members of the colon group of organisms was inoculated into dextrose tryptophane broth, nutrient gelatin, adonitol bouillon, Dunham peptone solution and saccharose bouillon. Methyl red test and Voges-Proskauer test for acetyl-methyl-carbinol was made on the dextrose tryptophane broth cultures, and the indol test on the Dunham peptone solution culture. Each culture was further inoculated into salicin, glycerol, dextrose and starch bouillon, nitrate bouillon, sorbitol, levulose, raffinose, mannitol, maltose, arabinose, dextrin, dulcitol and galactose bouillon and litmus milk. The reactions of these bacteria to the differential media are shown in table 5.

To determine their pathogenicity each of cultures FH 6 and FS 2 was injected subcutaneously into two guinea pigs and intraperitoneally into another two guinea pigs. One-half a gram of the pure culture was given per os to each of two guinea pigs and to one rabbit. In all cases no deleterious effect, even to a slight degree, was manifested by the laboratory animals, even after a period of two weeks.

Experiment 7. On the determination as to whether or not the water contains pathogenic bacteria. A sample of water from the water main was centrifuged (in a hand centrifuge) for 10 minutes. The centrifuge tubes were sterilized before being used. The lower half of the column of water in the centrifuge tube was injected in 5 cc. doses subcutaneously into two guinea pigs and one rabbit and intraperitoneally into three guinea pigs and one rabbit. The laboratory animals showed neither lesions nor symptoms of infection after a period of two weeks.

DISCUSSION OF RESULTS

Bacterial count per cc. of the water

The bacterial counts as shown in table 1 were the averages of the different counts made from two or more plates. The bacterial counts on sunny days, as those made in March and April, ranged from 730 to 1,045 per cc. On sunny days even in the rainy season, as in the greater part of August and September, the average count was 1,241 bacteria per cc. This number does not mean, however, that the count is only a little over 1,000 bacteria on any sunny day. The lowest bacterial counts, that is, from 730 to 1,241 per cc., were obtained from samples collected after at least two weeks of continuous sunny weather with no rainstorm immediately preceding this period. This fact is supported by the results obtained on December 20, 1929, when the bacterial counts ranged from 4,350 to 4,450 per cc. The

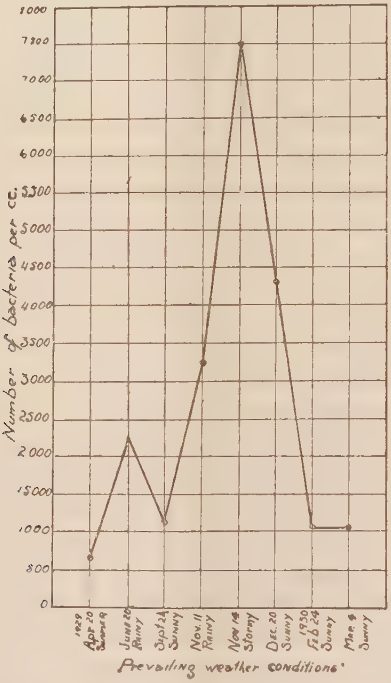

Chart 1.—Curve showing variation in bacteria counts according to prevailing weather conditions.

sample in this case had been collected on sunny days, but in the early part of November, 1929, there were many days when torrential rain fell and in the latter part of the month there were stormy days.

The bacterial counts on rainy days ranged from 2,820 to 3,350 per cc., while those on and soon after stormy days ranged from 4,450 to 7,700 per cc. These high bacterial counts were brought about by the fact that on stormy days the soil bacteria from the banks of the Molawin Creek as well as the bacteria on the leaves of plants were washed down into the water in the creek. The accumulation of leaves in the water and their subsequent decay created a favorable condition for the growth of many species of bacteria. As shown in table 1 and by the graph (chart 1) there was a great variation in bacterial counts according to the prevailing weather conditions.

There is no strict standard as to the number of bacteria a water may contain per cc. and still be classified as potable. Koch's standard of 100 bacteria per cc. is generally given for a potable water. Sternberg (cited by Park and Williams, 1920) considered that a water containing less than 100 bacteria per cc. was presumably from a deep source and uncontaminated by surface drainage; that one with 500 bacteria was open to suspicion; and that one with over 1,000 bacteria was presumably contaminated by sewage or surface drainage. These opinions are now considered as conservative because it is quite impossible to accurately determine the potability of water from a bacterial count alone. Even in woodland springs several hundred bacteria per cc. have been frequently found (Park and Williams, 1920). According to Stitt (1923) it is by the qualitative rather than the quantitative analysis that one should judge a water as to its potability. The water supply under study is undoubtedly contaminated by surface drainage only on rainy days. However, this surface drainage comes from the virgin forest and as such the water may be potable despite the fact that its bacterial count is high.

Colon presumptive tests

As shown in table 2, even as small an amount as 0.01 cc. of the water was positive for the colon presumptive test. The same amount of the sample collected from Molawin Falls and from the intake of the water system was also positive. If the qualitative analysis of this particular water were to be based only on this information, the result obtained would be very far beyond the maximum limit of bacteriological impurity.

Owing to the presence of a great number of lactose-fermenting bacteria in the water, as shown by the colon presumptive tests, it was presumed that the water was grossly contaminated with bacteria belonging to the colon group of intestinal bacteria. The presumptive tests were partially confirmed by the growth of vermillion red colonies on Endo plates inoculated with a sample of the water. In general the appearance of the colonies was quite characteristic of *Escherichia coli.*

Some health officers regard the presence in water of lactose-fermenting bacteria as an indication of contamination by human or animal excreta. This test is now considered as frequently if not always fallacious. Schöbl and Ramirez (1925) proved that even though lactose-fermenters other than *Escherichia coli* are frequently present in human and animal feces, owing to their wide distribution in nature and their presence in places where fecal contamination is excluded, these bacteria as a group cannot be considered as an indication of fecal contamination. While the presumptive test for *E. coli* is considered the most useful method available for determining the sanitary quality of water, according to Thompson (1927), it is subject to certain irregularities, chief of which is the occurrence of positive presumptive tests which fail to reveal the presence of the colon bacillus when subsequently subjected to the usual confirmatory tests. The same writer observed that non-conforming positive presumptive tests, which occur with great frequency in certain waters, had been ascribed by various investigators to the presence of aerobic spore-bearing lactose-fermenting bacteria and gas-producing symbiotic group.

Determination of a probable source of the lactose-fermenting bacteria in the water

In view of the abundance of the lactose-fermenting bacteria in the water under study, it was necessary to attempt to determine a probable source of these organisms as well as their probable distribution in nature. As shown in table 3, 12 out of 25 leaves collected at Molawin Falls and 23 out of 50 leaves collected from the river bed above the intake of the Los Baños Colleges water supply were found to harbor a great number of lactose-fermenting bacteria. No attempt was made to identify these bacteria. The water in the intake passes through Molawin Falls. It should be noted that Molawin Falls is in the midst of a virgin forest at an elevation of 267 meters and is more than two kilometers from the nearest habitation.

Hence these lactose-fermenting bacteria are prevalent in isolated places, at least in this part of Maquiling Forest, where there is no possibility of bacteria-laden dust from the streets or from around human habitations settling on the leaves of the plants.

Completed tests

As shown in table 4, cultures FS 3, FH 4, and FH 6 possessed morphological features and staining reactions characteristic of *Escherichia coli*. Table 5 shows the reactions of these coli-like bacteria to differential media and tests. Cultures FS 3, FH 4, and FH 6 are probably identical since they differed but very slightly in their cultural features. They were negative to methyl red test. All the three cultures were not identical to *E. coli* in their growth on the eosin-methylene-blue lactose agar. Schöbl and Ramirez (1925) pointed out that true *E. coli* can be quite readily distinguished from the other members of the intestinal group by the type of its colony on the eosin-methylene-blue lactose agar plate. Furthermore, their reactions to several differential media, as in saccharose and arabinose broth and in litmus milk, as well as their ability to produce acetyl-methyl-carbinol and their failure to produce indol, clearly show that these bacteria are neither true *E. coli* nor members of the colon group. Presumably, however, they belong to an intestinal group of bacteria.

According to Stitt (1923), the demonstration for the presence of *E. coli* may from a practical standpoint be considered as a positive evidence of fecal contamination. He calls attention, however, to the fact that there are organisms from cereals which correspond culturally to *E. coli*, and that the feces of animals contain an organism which cannot be differentiated from the colon bacillus of human origin. Comparative tests of *E. coli* strains, according to Schöbl and Ramirez (1925), failed to show any criterion for the differentiation of *E. coli* of human origin from *E. coli* of animal origin.

Identification of the coli-like bacteria isolated from the water

The bacteria in cultures FS3, FH4, and FH6 are motile and have neither capsule nor spore. They are rod-shaped, measuring 0.553 to 0.632 by 1.1 to 1.869 microns, and they occur singly or in pairs. They are Gram-negative. By their morphology they belong to the order *Eubacteriales* and to the family *Bacteriaceae* Cohn, 1872. Like the *E. coli* they belong to the tribe *Bacterieae* Committee S. A. B., 1920. Since these cultures produced acetyl-methyl-carbinol they do not belong to the genus *Escherichia* but to the genus *Aerobacter* Beijerinck, 1900. Like the bacteria under the genus *Escherichia*, the bacteria under the genus *Aerobacter* commonly occur in the intestinal canal of normal animals. (Bergey, 1925.) By their reactions to differential media, as shown in table 5, it can be seen distinctly that these bacteria belong to the species *Aerobacter cloacae* (Jordan, 1890) Bergey et al. These cultures did not produce acid and gas in adonitol broth, hence they cannot be suspected to be of fecal origin. As culture of *Aerobacter cloacae* that produced acid and gas in adonitol broth may or may not be of fecal origin (Stitt, 1923) so a culture that did not ferment adonitol can not be of fecal origin.

Culture FS2 is almost identical to the preceding three cultures as can be seen in table 5 with the exception that it did not ferment dulcitol but did ferment adonitol. This organism is a non-motile rod measuring 0.67 by 1.1 to 1.96 microns. It occurs singly or in pairs. It also belongs to the genus *Aerobacter*. Being non-motile and being unable to ferment dulcitol, it belongs to the species *Aerobacter aerogenes* (Escherich, 1886) Beijerinck, 1900. Owing to its ability to ferment adonitol it may, with a high degree of probability, be of fecal origin. *Aerobacter aerogenes* of fecal origin tends to ferment adonitol while that of vegetable origin as a rule fails to ferment adonitol (Stitt, 1923). As with *Aerobacter cloacae,* the normal habitat of *Aerobacter aerogenes* is the intestinal canal of normal animals, but, according to Bergey (1925), this bacterium is also widely distributed in nature.

Assuming that this culture FS 2 (*Aerobacter aerogenes*) is of fecal origin, it is then most probable that this organism came from the feces of numerous wild animals inhabiting the Maquiling Forest. These animals naturally go down the Molawin Creek above the intake of the water system not only to drink but also to catch their prey, and while in the river they scatter their feces on the rocks or in the water. The feces on the rocks may subsequently be washed down into the river water by the rain. The fact that the colon bacillus cannot be demonstrated from the water does not contradict the probability of the above assumption. The individuals of most species of bacteria die quite rapidly in pure water, because pure water is not a favorable medium for the multiplication of bacteria save those having their normal habitat in water (Moore, 1912). However, the same authority stated that a few species of bacteria not normally found in water can persist for a long time. In this particular case, if this *Aerobacter aerogenes* really came from the feces of either man or animal, it can be safely stated that the colon bacillus that was originally with this *A. aerogenes* probably could not persist in the water under study, but the species of bacteria under the genus *Aerobacter* could persist in this water owing to their ability to adapt themselves to the new habitat.

The presence of adonitol-fermenting *Aerobacter aerogenes* alone in the water cannot be safely considered as an indication of fecal contamination. Schöbl and Ramirez (1925) found lactose-fermenting bacteria which produced acid and gas in adonitol yet they were isolated from the leaves of plants that were excluded from fecal contamination. According to Stitt (1923), the colon bacillus alone is considered the indicator of sewage contamination, and all tests, presumptive or positive, are based on the presence of this organism. The same authority advises that the decisions as to the sanitary quality of the water should rest not only upon finding the colon bacillus but also on its relative abundance. Since no colon bacillus can be isolated from this water, it is, therefore, free from sewage contamination, hence it is potable.

Determination as to whether or not the water contains some pathogenic bacteria

Animal inoculations failed to demonstrate the presence of any pathogenic bacteria. Neither abscess formation nor peritonitis developed in any of the cases. Hence, the water does not contain pathogenic species of bacteria.

SUMMARY

1. The water supply of the Los Baños Colleges has a high and variable bacterial count because it is contaminated by surface drainage which occurs

only on rainy days and this surface drainage comes only from the virgin forest far from human habitation.

2. Since a complete bacteriological analysis failed to demonstrate the presence of the colon bacillus, it is believed that the water is quite free from fecal contamination and as such it is potable despite the fact that its bacterial count is rather high.

3. This water is of good sanitary quality not only because it does not contain the colon bacillus but also because it does not contain any pathogenic bacteria.

4. Colon presumptive tests for this water should not be relied upon to judge its sanitary quality because the leaves of plants along its source as well as the water itself contain a great number of lactose-fermenting bacteria some of which are *Aerobacter cloacae* and *Aerobacter aerogenes.*

5. In view of the proximity of several *caingin* and the trails leading to the top of Mount Maquiling, to the barrio of Bitin, and to the town of Santo Tomas in Batangas Province, it may be possible that some people may frequent the source of Molawin Creek above the intake and through carelessness they may defecate on the banks or in the river bed and then through the agency of small animals and rain their feces may gain access into the water.

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TABLE 1

Showing the bacterial counts per cc. of samples of water collected from the water main and faucets

DATE	WEATHER	SAMPLES	NUMBER OF BACTERIA PER CC.
April 20, 1929	Sunny	Forest School, main	730
	"	Faculty Hill, main	870
June 20, 1929	Rainy	Forest School, main	2,840
	"	Faculty Hill, main	2,720
	"	Copeland Heights, faucets	1,950
	"	Molawin Hall, faucet	2,770
	"	Chem. Lab., faucets	2,250
	"	Bact. Lab., faucets	2,130
September 24, 1929	Sunny	Forest School, main	1,080
	"	Faculty Hill, main	1,100
	"	Copeland Heights, faucets	1,460
	"	Molawin Hall, faucet	1,630
	"	Chem. Lab., faucets	1,120
	"	Bact. Lab., faucets	1,060
November 11, 1929	Rainy	Forest School, main	3,350
	"	Faculty Hill, main	3,200
November 14, 1929	Stormy	Forest School, main	7,300
	"	Faculty Hill, main	7,700
December 20, 1929	Sunny	Forest School, main	4,350
	"	Faculty Hill, main	4,450
February 24, 1930	Sunny	Forest School, main	990
	"	Faculty Hill, main	1,077
March 4, 1930	Sunny	Forst School, main	1,045
	"	Faculty Hill, main	1,020

TABLE 2

Showing the colon presumptive tests

AMOUNT OF SAMPLES INOCULATED	OCT. 15, 1929		OCT. 15, 1929		FEB. 22, 1930		MARCH 9, 1930	
	Faucet		Water main		Mol. Falls		Intake	
	Acid	Gas	Acid	Gas	Acid	Gas	Acid	Gas
cc.		*per cent*		*per cent*		*per cent*		*per cent*
10.0	+	25	+	30				
10.0	+	40	+	45				
10.0	+	15	+	35				
10.0	+	45	+	25				
10.0	+	55	+	40				
1.0	+	30	+	50	+	25	+	60
0.1	+	25	+	40	+	20	+	30
0.01	+	10	+	15	+	10	+	20
0.001	—	—	—	—	—	—	+	—
0.0001	—	—	—	—	—	—	—	—

TABLE 3

Showing the prevalence of lactose fermenters on the leaves of plants in Maquiling Forest

MOL. FALLS, FEB. 22, 1930			INTAKE, MARCH 9, 1930			INTAKE, MARCH 9, 1930		
Leaves	Acid	Gas	Leaves	Acid	Gas	Leaves	Acid	Gas
1	+	—	1	+	—	26	+	+
2	+	+	2	+	+	27	—	—
3	+	+	3	+	—	28	—	—
4	—	—	4	+	—	29	+	+
5	+	—	5	—	—	30	+	—
6	+	+	6	+	+	31	+	+
7	—	—	7	+	+	32	+	+
8	+	+	8	+	+	33	+	—
9	—	—	9	+	—	34	—	—
10	+	—	10	+	+	35	+	+
11	+	+	11	+	+	36	+	+
12	+	+	12	—	—	37	—	—
13	—	—	13	+	+	38	—	—
14	+	+	14	—	—	39	+	—
15	+	+	15	—	—	40	+	+
16	+	+	16	+	+	41	—	—
17	+	—	17	+	+	42	+	+
18	—	—	18	—	+	43	+	+
19	+	+	19	+	+	44	+	—
20	+	—	20	+	—	45	+	—
21	—	—	21	—	—	46	+	+
22	—	—	22	+	+	47	—	—
23	+	+	23	+	+	48	+	+
24	+	+	24	+	+	49	—	+
25	+	+	25	+	—	50	+	—

TABLE 4

Showing the completed tests

CULTURES FROM COLI-LIKE COLONIES ON ENDO	LACTOSE BROTH 24 hours		MORPHOLOGICAL AND STAINING CHARACTERISTICS			
	Acid	Gas	Type	Spore	Gram stain	Motility
		per cent				
FS 1	+	—				
FS 2	+	55	bacilli	—	negative	non-motile
FH 1	+	—				
FH 2	+	45	strep.	—	positive	
FS 3	+	60	bacilli	—	negative	motile
FS 4	+	—				
FS 5	+	—				
FH 3	+	10	bacilli	+	negative	motile
FH 4	+	15	bacilli	—	negative	motile
FH 5	+	—				
FH 6	+	30	bacilli	—	negative	motile
FH 7	+	—				
FH 8	+	—				

TABLE 5

Showing the reactions on differential media of coli-like bacteria isolated from water

DIFFERENTIAL MEDIA AND TESTS	CULTURE FS 3	CULTURE FH 4	CULTURE FH 6	CULTURE FS 2
Adonitol	—	—	—	+
Salicin	+	+	+	+
Saccharose	+	+	+	+
Glycerol	+	+	—	+
Dextrose	+	+	+	+
Starch	—	—	—	+
Sorbitol	+	+	+	+
Levoluse	+	+	+	+
Raffinose	+	+	+	+
Mannitol	+	+	+	+
Maltose	+	+	+	+
Arabinose	gas only	+	gas only	gas only
Dulcitol	+	+	+	—
Galactose	+	+	+	+
Rhamnose	+	+	+	+
Dextrin	+	+	+	+
Indol	—	—	—	—
Methyl red	—	—	—	—
Acetyl-methyl-carbinol	+	+	+	+
Nitrate broth	nitrite —	nitrite —	nitrite —	nitrite —
E. M. B. agar	B. coli —	B. coli —	B. coli —	B. coli —
Litmus milk	slight coagulation	slight coagulation	slight coagulation	slight coagulation
Gelatin	liquefaction stratified	liquefaction stratified	liquefaction stratified	liquefaction stratified

AGE DETERMINATION BY THE ERUPTION OF THE INCISOR TEETH IN THE OX REARED UNDER LOS BAÑOS CONDITIONS[1]

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Buyers of oxen whether for work, for breeding purposes or for slaughter usually desire to know the accurate ages of the animals they are buying. Cattle breeders, also, find this knowledge advantageous. Heretofore both buyers and breeders have depended very largely on the information furnished them by the sellers and by registration certificates. For in the Philippine Islands, as a rule, cattle owners do not keep records of the births of their animals, hence the ages given are based on memory. That the age given for many animals is not correct is a foregone conclusion.

In the course of the experiments on crossbreeding cattle in the Department of Animal Husbandry, College of Agriculture, which have been carried on for over six years, some data pertaining to the questions of age determination by the eruption of the incisor teeth have been accumulated. In these experiments the dentition of the animals was very carefully examined at birth, once a week for a period of six weeks after birth, and every month thereafter until the animals were discarded. These data are here presented for the purpose of making available a more accurate means of determining the age of the ox than is now used.

Seventy-eight animals, in all, are included in this study, of which three are pure Philippine Native cattle, four are pure Herefords, sixteen are pure Nellores, and the remaining fifty-five are grades. The ages at which the temporary and permanent incisors were observed in these animals are shown in table 1. Only a few general statements need be given about this table.

1. In 25 out of 76 calves the third pair of temporary incisors, sometimes called laterals, appeared earlier than the second pair (first intermediate). In 47 of these 76 calves both the second and the third pairs erupted at the same time and in only 4 out of the 76 did the second appear earlier than the third.

2. Unlike the temporary, the permanent incisors appeared in the order of the first, second, third, and fourth pairs. That is, in no case did the second pair erupt before the first, the third before the second, or the fourth before the third.

3. Out of a total of 50 animals examined for the appearance of the first pair of permanent incisors there were 13 in which the left erupted be-

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fore the right, and 3 in which the right appeared before the left. Out of 42 animals examined for the appearance of the second pair there were 9 in which the left appeared first, and 5 in which the right appeared before the left. Out of 33 animals examined for the appearance of the third pair of permanent incisors there were 6 in which the left member appeared first and 2 in which the right appeared before the left. The total of these ratios 28 to 10 indicates that there is a general tendency for the left members of the pair to make their appearance earlier than the right.

It was first thought that there might be a difference in the time of appearance of the teeth in the males and in the females. To determine if this conjecture were correct tables 2 and 3 were constructed; these show the frequency distribution in time of eruption of the temporary and permanent incisors in the males and females. It will be seen from these tables that there seems to be a slight indication that both temporary and permanent incisors appear earlier in the males. For example, taking the temporary first, the first pairs were present at birth in 70.97 per cent of the males and in 63.93 per cent of the females. In the males the second pair were present at birth in 54.84 per cent, the third in 51.51 per cent, and the fourth in 22.58 per cent. In the females, the second pair occurred in 39.96 per cent, the third pair in 60.00 per cent, and the fourth in 20 per cent.

As to the permanent incisors, it was found that in the males the earliest central and first intermediate incisors erupted one month in advance of the earliest in the females; in the females, the pairs of the last few incisors were cut later than in the males. When these differences, however, are treated statistically, it is found that the differences are not significant, thus showing that in the ox sex does not enter as a factor in the eruption of either temporary or permanent incisor teeth. The subject can, therefore, be discussed without considering the sex of the animal.

In table 4 are shown the ages at which the temporary incisors erupted and the frequency of their appearance in the cattle studied, both male and female. It may be seen from this table that 52 out of the 78 calves studied were born with their first pair of milk teeth, giving a ratio of 66.67 per cent; 34 out of 77 calves, 44.16 per cent, were born with their second pair. Out of the 76 calves examined for the next two pairs, 43 calves giving a ratio of 56.58 had their third pair and 16, 21.05 per cent, had the fourth pair at birth.

As one looks over the table his attention will be claimed by the occurrence of a consistent bimodal curve. There is one mode at birth, the other coming at the end of one week period. These data should be quite conclusive evidence that milk teeth in the ox develop many days before the calves are born. The results obtained in this study permits the general statement that the first pair of temporary incisors are complete within one week, the second within two, the third within three, and the fourth within four weeks after birth.

Table 5 shows the time in months and the frequency in which the permanent incisors appeared. It may be seen from this table that the first permanent incisor appeared between 22 and 32 months with the mean at 26.86 ± 0.218 months; the second appeared between 27 and 38 months with the mean at 32.93 ± 0.283 months, the third between 34 and 46 months with the mean at 40.89 ± 0.379 months; and the fourth between 44 and 64 months with the mean at 51.82 ± 0.296 months. To show how variable is the time of the appearance, the standard deviations and coefficient of variability are given.

From a practical standpoint the statement can be made that in the ox reared under Los Baños conditions, the first pair of permanent incisors appear between 2 to 2-1/2 years after birth, the second pair between 2 to 3 years; the third pair between 3 to 4 years; and the fourth pair between 4 to 5 years. These figures are accurate to within a period of a little over two months more or less.

Comparing the data obtained in this investigation with those obtained by foreign investigators it is found that on the whole the incisors of the cattle studied at the College erupted later than those reported by American workers. This difference can be seen readily by reference to the following tabulation in which the College data are compared with those of Sisson (1917) and of Pope (1919).[2]

Average periods of eruption of the temporary and permanent incisor teeth in the ox as reported by three different investigators

A. Temporary

PAIRS OF INCISORS	INVESTIGATORS		
	College data	Sisson	Pope
First or central	1 week	Birth to 3 weeks	Entire 8 temporary Incisors appear Before 4 weeks after Birth
Second first intermediate	2 weeks		
Third second intermediate or laterals	3 weeks		
Fourth corners	4 weeks		

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[2] Pope, George W. 1919. Determining the age of cattle by the teeth. U. S. Dept. Agric. Farmers' Bull. 1066: 3–4. *Fig. 1–6.*

Sisson, S. 1917. The anatomy of domestic animals. 2nd ed., xvi+930 p., 725 fig. Philadelphia: W. B. Saunders Company.

B. Permanent

First or central	2—2½ years	1½—2 years	Appear before 2 years. Fully developed at 2 years.
Second first intermediate	2—3 years	2—2½ years	Appear between 2—2½ years. Fully developed at 3 years.
Third second intermediate or laterals	3—4 years	3 years	Appear between 3½ years. Begin to wear at 4 years.
Fourth or corners	4—5 years	3½—4 years	Appear between 4½ years. Fully developed at 5 years

It may be seen from this table that with the College cattle both temporary and permanent incisors erupted somewhat later than those reported by Sisson and Pope. In the case of temporary teeth the difference is not much, only one week; but in the case of the permanent the difference is at least six months. It occurred to the writers to inquire whether the appearance of the incisors might not be correlated with maturity of the animal. If such be the case the question of selection for early maturity can be greatly expedited. Unfortunately, however, the College data are not quite sufficient, as yet, to make any statement on this point. There are indications that the Herefords included in these studies mature earlier than either the Nellores or the Natives; they also develop the permanent incisor teeth earlier. But the number studied is as yet too few to justify definite conclusions.

SUMMARY AND RECOMMENDATIONS

1. In the ox the third pair of temporary or deciduous incisors may and in fact do in 30 per cent of the cases studied appear earlier than the second pair. The permanent pairs, however, erupt in the usual order.

2. There is a decided tendency in the case of the permanent incisors for the left members of the pair to cut through earlier than the right members.

3. Sex does not enter as a factor in the time of eruption of the incisors, either temporary or permanent.

4. The temporary incisors make their appearance as follows: First pair, within one week after birth; second pair, two weeks; third pair, three weeks; and fourth pair, four weeks.

5. The permanent incisors erupt as follows: First pair within 2 to 2½ years after birth; the second pair, 2 to 3 years; third pair, 3 to 4 years,

and fourth pair, 4 to 5 years. The figures are close to a period of plus or minus two months.

6. When compared with the results of the work on the same subject reported by American investigators these determinations are found to be greater by at least six months. Conclusion as to whether the difference is due to the fact that Philippine cattle mature late cannot be given because of inadequate data to determine whether a correlation between maturity and eruption of permanent teeth exists in the ox.

7. This subject is of sufficient practical importance to justify its being continued until conclusive results are obtained.

TABLE 1

Showing the ages at which the temporary and permanent incisors in the ox were observed

ANIMALS UNDER STUDY		TEMPORARY INCISORS				PERMANENT INCISORS			
H. No.	Sex	1st pair	2nd pair	3rd pair	4th pair	1st pair	2nd pair	3rd pair	4th pair
						months	*months*	*months*	*months*
			Group I.—Native Cattle						
M/[a]	♂	1 week	2 weeks	1 week[b]	2 weeks	29	34	42	
174	♀					29	36	42	
C/[a]	♀					29[c]	34	42	
			Group II.—Nellore Cattle						
32	♂					30	36[c]	42	56
33	♂					28	35	40	54
38	♂	1 week	2 weeks	1 week[b]	3 weeks				
39	♂	at birth	1 week	at birth[b]	2 weeks	23	27		
46	♂	at birth	2 weeks	at birth[b]	3 weeks				
51	♂	at birth	at birth	at birth[b]	2 weeks				
40	♂	at birth	at birth	1 week	4 weeks				
34	♀					27	35	43	64[d]
35	♀	1 week	1 week	1 week	2 weeks	28	36	42	52
36	♀	2 weeks	2 weeks	2 weeks	2 weeks	31	37[c]	44	51
41	♀	5 days	2 weeks	5 days[b]	3 weeks	25	33[c]		
42	♀	at birh	at birth	at birth	3 days				
44	♀	at birth							
49	♀	at birth	1 week	at birth[b]	4 weeks				
50	♀	at birth	2 days	2 days	3 weeks				
52	♀	at birth	at birth	at birth	3 weeks				
			Group III.—Hereford Cattle						
18	♂	at birth	at birth	at birth	at birth				
13[a]	♀					24	28	36[c]	48
14	♀	1 week	1 week	1 week	1 week	24	31	34	45
17	♀	1 week	1 week	1 week	3 weeks	25			
			Group IV.—Half Nellore and Half Native						
65[a]	♂					24	35[c]	42[c]	58
97	♂	1 week	2 weeks	2 weeks	2 weeks	23[c]	28	37[c]	44[d]
106	♂	2 days	2 weeks	2 days[b]	2 weeks	25	32		
168	♂	at birth	at birth	at birth	at birth				
100	♀	at birth	at birth	at birth	at birth	32	38	46	55
104	♀	1 week	1 week	1 week	1 week	31	38	46	
112	♀	at birth	at birth	at birth	at birth	24	36	46	
175	♀	at birth	1 week	at birth[b]	1 week				

Group V.—Half Hereford and Half Native

87[a]	♂					25	31[c]	40[c]	56
111	♂	3 days	3 days	3 days	3 days				
	♂	2 days	1 week	2 days[b]	2 weeks				
132	♂	2 days	1 week	2 days[b]	1 week	26			
136	♂	at birth	at birth	1 week	1 week				
108	♀	3 days	3 days	3 days	1 week	24[c]	30	40[c]	
137	♀	at birth	at birth	at birth	1 week				
135	♀	1 week	1 week	1 week	2 weeks				
144	♀	at birth	at birth	at birth	3 weeks				
149	♀	at birth	at birth	at birth	at birth				

Group VI—Half Hereford and Half Nellore

84[a]	♂					25	32	38	46
85[a]	♂					25	32	38	50
93	♂	1 week	1 week	1 week	1 week	27[c]	34[c]	42	48
101[a]	♂					28	34[d]		
171	♂	at birth	at birth	at birth	at birth				
130	♀	at birth	1 week	at birth[b]	1 week	29[c]			
170	♀	at birth	at birth	at birth	at birth				

Group VII.—Three-fourth Nellore and One-fourth Native

66[a]	♂					27	34[c]	40	
166	♂	at birth	at birth	1 week	1 week				
86	♂					25[c]	31	38	50
99	♀	1 day	1 day	1 day	1 week	27[c]	34[d]	44[d]	55
141	♀	at birth	at birth	at birth	4 weeks				
145	♀	at birth	at birth						
159	♀	at birth	at birth	at birth	3 weeks				
162	♀	at birth	1 week	at birth[b]	4 weeks				
163	♀	at birth	2 weeks	at birth[b]	4 weeks				

Group VIII.—Half Hereford, One-fourth Nellore and One-fourth Native

79[a]	♂					26[c]	33	41[c]	57
98	♂	1 week	1 week	1 week	1 week				
107	♂	at birth	2 weeks	at birth[b]	2 weeks	23[c]	33	36[d]	45[d]
118	♂	at birth	1 week	at birth[b]	1 week	22[c]	27[c]	34	
125	♂	at birth	at birth	at birth	1 week	24	29[d]		
150	♂	at birth	1 week	1 week	1 week				
78[a]	♀					24	32	38	44
88	♀	at birth	at birth	at birth	at birth	28[c]	36[c]	44	56
96	♀	1 week	1 week	1 week	1 week	25[c]	32[d]	39	54
102	♀	1 week	1 week	1 week	1 week	27	33	42	
110	♀	3 days	1 week	3 days[b]	1 week	25	36	45	
121	♀	at birth	1 week	at birth[b]	1 week	25	32		
131	♀	at birth	1 week	at birth[b]	1 week	26			
134	♀	at birth	at birth	at birth	at birth				
147	♀	1 week	1 week	at birth[b]	1 week				

Group IX—Three-fourths Hereford, One-eighth Nellore and One-eighth Native

120	♂	2 days	2 days	2 days	4 weeks	26	32		
133	♂	at birth	at birth	at birth	at birth	26			
143	♂	at birth	at birth	at birth	at birth				
148	♂	at birth	at birth	at birth	at birth				
103	♀	at birth	1 week	1 week	1 week	27[c]	33[d]	42	52
109	♀	2 days	2 days	2 days	2 days				
128	♀	at birth	1 week	at birth[b]	1 week	27[d]			

Group X.—One-fourth Hereford and Three-fourths Native

119	♂	at birth	at birth	at birth	1 week	24	31	38	
123	♀	3 days	1 week	3 days[b]	1 week	25[d]	31		
122	♀	at birth	at birth	at birth	at birth	25	32		

Group XI.—One-fourth Hereford, Half Nellore and One-fourth Native

161	♂	at birth	at birth	1 week					
142	♀	at birth	at birth	at birth	1 week				

Group XII.—Three-fourths Hereford and One-fourth Nellore

157	♂	at birth	at birth	at birth	at birth				

Group XIII.—Seven-eighths Nellore and One-eighth Native

156	♀	at birth	1 week	at birth[b]	2 weeks				

Group XIV.—One-fourth Hereford, Five-eighths Nellore and One-eighth Native

152	♂	at birth	at birth	at birth	4 weeks				
154	♂	at birth	at birth	3 weeks[b]	4 weeks				
155	♂	at birth	at birth	at birth	2 weeks				
117	♀	at birth	at birth	at birth	at birth	23			
140	♀	at birth	at birth	at birth	at birth				
160	♀	at birth	1 week	at birth[b]	3 weeks				
127	♀	3 days	1 week	1 week	1 week	27[d]			

M and C—These animals had no herd number. The first was carried in the records under the name of Magdaleno; the second under the name of Culasa.

[a] Appearance of temporary incisors not observed.

[b] Was observed to appear before the second pair of temporary incisors.

[c] Permanent left member was observed to appear before the right member.

[d] Permanent right member was observed to appear before the left member.

TABLE 2

Showing the age at which the temporary incisors in male and female cattle appeared and the frequency of their appearance

Males

AGE	FIRST PAIR		SECOND PAIR		THIRD PAIR		FOURTH PAIR	
	Frequency	Per cent	Frequency	Per cent	Frequency	Per cent	Frequency	Per cent
At birth	22	70.97	17	54.84	16	51.51	7	22.58
Before 1 week	5	16.13	2	6.45	5	16.13	2	6.45
One week	4	12.90	7	22.58	8	25.81	9	29.03
Two weeks			5	16.13	1	3.22	7	22.58
Three weeks					1	3.22	2	6.45
Four weeks							4	12.90
Total	31	100.00	31	100.00	31	99.99	31	99.99

Females

At birth	30	63.83	17	36.96	27	60.00	9	20.00
Before 1 week	7	14.89	4	8.70	7	15.56	2	4.44
One week	9	19.15	21	45.65	10	22.22	18	40.00
Two weeks	1	2.13	4	8.70	1	2.22	5	11.11
Three weeks							7	15.56
Four weeks							4	8.89
Total	47	100.00	46	100.01	45	100.00	45	100.00

TABLE 4

Showing the age at which the temporary incisors in cattle of both sexes appeared and the frequency of their appearance

AGE	FIRST PAIR		SECOND PAIR		THIRD PAIR		FOURTH PAIR	
	Frequency	Per cent	Frequency	Per cent	Frequency	Per cent	Frequency	Per cent
At birth	52	66.67	34	44.16	43	56.58	16	21.05
Before 1 week	12	15.38	6	7.79	12	15.79	4	5.26
One week	13	16.67	28	36.36	18	23.68	27	35.53
Two weeks	1	1.28	9	11.69	2	2.63	12	15.79
Three weeks					1	1.32	9	11.84
Four weeks							8	10.53
Total	78	100.00	77	100.00	76	100.00	76	100.00

TABLE 3

Showing the frequency in which the permanent incisors appeared in the males and the females

Males

AGE	FIRST PAIR		SECOND PAIR		THIRD PAIR		FOURTH PAIR	
	Frequency	Per cent	Frequency	Per cent	Frequency	Per cent	Frequency	Per cent
months								
22	1	4.54						
23	3	13.64						
24	3	13.64						
25	5	22.73						
26	4	18.18						
27	2	9.09	2	10.00				
28	2	9.09	1	5.00				
29	1	4.54	1	5.00				
30	1	4.54	0					
31	0		3	15.00				
32	0		4	20.00				
33			2	10.00				
34			4	20.00	1	6.67		
35			2	10.00	0			
36			1	5 00	1	6.67		
37			0		1	6.67		
38			0		4	26.67		
39					0			
40					3	20.00		
41					1	6.67		
42					4	26.67		
43					0			
44					0		1	9.09
45					0		1	9.09
46					0		1	9.09
47							0	
48							1	9.09
49							0	
50							2	18.18
51							0	
52							0	
53							0	
54							1	9.09
55							0	
56							2	18.18
57							1	9.09
58							1	9.09
59								
60								
61								
62								
63								
64								
Total...	22	99.99	20	100.00	15	100.02	11	99.99
Females								
22	0							
23	1	3.57						
24	5	17.86						
25	7	25.00						
26	1	3.57						
27	6	21.43	0					
28	2	7.14	1	4.54				
29	3	10.71	0					
30	0		1	4.54				
31	2	7.14	2	9.09				
32	1	3.57	4	18.18				
33			3	13.64				
34			2	9.09	1	5.56		
35			1	4.54	0			
36			5	22.73	1	5.56		
37			1	4.54	0			
38			2	9.09	1	5.56		
39					1	5.56		
40					1	5.56		
41					0			
42					5	27.78		
43					1	5.56		
44					3	16.67	1	9.09
45					1	5.56	1	9.09
46					3	16.67	0	
47					0		0	
48							1	9.09
49							0	
50							0	
51							0	
52							1	9.09
53							2	18.18
54							0	
55							1	9.09
56							2	18.18
57							0	
58							0	
59								
60								
61								
62								
63								
64							1	9.09
Total...	28	99.99	22	99.98	18	100.04	10	99.99

TABLE 5

Showing the frequency distribution in the eruption of the permanent incisor teeth in cattle

AGE	FIRST PAIR		SECOND PAIR		THIRD PAIR		FOURTH PAIR	
	Frequency	Per cent	Frequency	Per cent	Frequency	Per cent	Frequency	Per cent
months								
22	1	2.00						
23	4	8.00						
24	8	16.00						
25	12	24.00						
26	5	10.00						
27	8	16.00	2	4.76				
28	4	8.00	2	4.76				
29	4	8.00	1	2.38				
30	1	2.00	1	2.38				
31	2	4.00	5	11.90				
32	1	2.00	8	19.05				
33			5	11.90				
34			6	14.29	2	6.06		
35			3	7.14	0			
36			6	14.29	2	6.06		
37			1	2.38	1	3.03		
38			2	4.76	5	15.15		
39					1	3.03		
40					4	12.12		
41					1	3.03		
42					9	27.27		
43					1	3.03		
44					3	9.09	2	9.09
45					1	3.03	2	9.09
46					3	9.09	1	4.54
47								
48							2	9.09
49								
50							2	9.09
51							1	4.54
52							2	9.09
53								
54							2	9.09
55							2	9.09
56							3	13.64
57							1	4.54
58							1	4.54
59								
60								
61								
62								
63								
64							1	4.54
	$M = 26.86 \pm 0.218$ mo. $\sigma = 2.29 \pm 0.154$ mo. c.v. = 8.78 ± 0.592%		$M = 32.93 \pm 0.283$ mo. $\sigma = 2.72 \pm 0.20$ mo. c.v. = 8.25 ± 0.605%		$M = 40.89 \pm 0.379$ mo. $\sigma = 3.23 \pm 0.268$ mo. c.v. = 7.92 ± 0.658%		$M = 51.82 \pm 0.296$ mo $\sigma = 2.06 \pm 0.209$ mo c.v. = 3.97 ± 0.403%	
Total..	50		42		33		22	

A SUMMARY OF THE SITUATION OF THE AGRICULTURAL CREDIT CO-OPERATIVE ASSOCIATIONS IN THE ISLAND OF PANAY[1]

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The island of Panay, one of the Visayan Group, is the fifth largest island of the Philippine Archipelago. It lies southeast of Luzon Island. Panay is divided into three provinces, Iloilo, Capiz, and Antique. As a whole, the island is an agricultural region. Rice, sugar cane, and corn are the principal crops. For the most part the farmers have small holdings, or are tenants or farm laborers. As a rule "they have no credit, because they are poor; and they are poor because they have no credit." Their principal source of capital is the money lender who charges usurious rates of interest.

The rural credit co-operative associations in Panay were established in 1917, two years after Act No. 2508 authorizing such organizations went into effect. The island has 75 municipalities in which 67 co-operative credit associations have been organized, distributed in the provinces as follows: 31 in Iloilo, 24 in Capiz, and 12 in Antique. These associations were regularly inspected during a period of about two years (1927-29) by the writer who as rural credit agent was working under the Bureau of Agriculture, now reorganized as Bureau of Plant Industry. In the preparation of the present paper, the writer had the advantage of his first hand information and personal experiences which he acquired in his work as rural credit agent. His purpose in writing this paper is to give co-operative associations in other regions the benefit of the mistakes, difficulties, problems, operations, and policies experienced by the associations in Panay. Outstanding cases encountered by the writer are cited; but for obvious reasons the identity of the persons, associations, municipalities, and provinces concerned in each instance are not divulged.

MEMBERSHIP AND ADMINISTRATION

Classes of membership

The rural credit associations in Panay had a total of 10,753 members according to the annual report to the Director of the Bureau of Plant Industry for the year ending December 31, 1928.[3] These members were dis-

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[2] Grateful acknowledgment is due the Rural Credit Division of the Bureau of Plant Industry which kindly furnished additional data for this paper.

[3] Annual reports for the year ending December 31, 1929, had not been submitted to the Bureau of Plant Industry by the respective associations at the time of this writing.

tributed among the three provinces as follows: 5,571 in Iloilo, 2,696 in Capiz, and 2,486 in Antique. Of these members, 4,385 were borrowers, distributed as follows: Iloilo, 2,218; Capiz, 1,280; Antique, 887. The members of the different associations in the island were from different walks of life. The majority of members in the associations organized in the provincial capitals as Iloilo, Capiz, and San José were mostly teachers, proprietors, and employees. Small farmers and farm laborers formed the minority. Despite the fact that the members belonged to the salaried class, the association in each of these provincial capitals was not as progressive and in as good standing as the associations located in the agricultural regions.

The loans granted by the associations in Iloilo, Capiz, and San José were relatively large. Many of the borrowers remained delinquent for years in the payment of their loans. From the data compiled in the writing of this paper, it was found that loans granted by the associations in these provincial capitals ranged from ₱100 to ₱1000 and most of them were due in 1924, 1925, 1926, and 1927. On the other hand, loans granted by associations located in the agricultural region were in smaller amounts, generally ranging from ₱50 to ₱100 and most of them were due in 1927, 1928, 1929, and 1930. These figures would seem to indicate that urbanized regions like Iloilo, Capiz and San José are not suitable places for organizing rural credit associations. The tendency among the board of directors to approve a wholesale extension and renewal of loans has reached a height of abuse of power in one of the provincial capitals mentioned. This practice has time and again been declared illegal. The act was commited so frequently that many of the borrowers whose loans had been indefinitely extended and renewed had died. Cases of this nature fill the dockets of the court of first instance at the present writing. Similar irregularities were committed among the associations in less urbanized regions. The reason for this is obvious. In the provincial capitals there is little or no agricultural land, so that loans made by the associations in these towns were used for purposes other than agricultural.

Causes of increase and decrease of membership

The increase and decrease of membership in an association depends on the efficiency and interest of the board of directors. When the number of members, borrowers, and depositors in an association increased each year, it was generally an indication of progress and good standing. Panay has about 10 of these progressive associations out of the 67 associations in the island. If the number of members and borrowers remained almost constant from year to year, it was taken as a sign of stagnation. Lack of capital was the principal cause of stagnation. There was a shortage of capital usually because no organized effort was made to increase the membership. It was true that an association could be aided financially by the Insular Government through the Rice and Corn Fund, which will be discussed later on. But before any association can have help from this fund, it must prove its ability to secure capital from its members. An association with a thousand pesos capital is fairly qualified to obtain government aid.

In one of the provinces there were two associations which will be designated here as "A" and "B", each of which tried to secure a loan of ₱10,000 from the Insular Government when neither association had a capital of more than ₱600. When these associations failed to obtain the government loan the directors gave no further attention to their duties as officers of the association. The municipal treasurer, who is the treasurer ex-officio of associations, kept on reporting the financial condition and membership list of these associations to the Director of the Bureau of Agriculture. This report contained the same figures from year to year with little or no alteration, as the associations were not functioning.

A similar state of affairs existed in three associations in another province. They were considered defunct associations in that province. In another province, two associations were in a similar state. One of the causes of their stagnation was failure to secure loans from the Rice and Corn Fund. Personal profit was apparently the motive of many persons who accepted the post of directorship in these associations.

Regional distribution of the associations

The agricultural credit co-operative associations in Panay are distributed in the four principal regions of the island; namely, agricultural, mountain, coastal, and urban regions. The associations in these regions were distributed as follows: 30 in the agricultural, 16 in the coastal, 15 in the mountain, and 6 in the urban. Analysis of the memberships from their annual reports ending December 31, 1928, showed that the agricultural region ranked first in the number of members; the coastal, second; the mountain, third; and the urban, fourth. The agricultural region had 51 per cent of their members as borrowers; the mountain, 43 per cent; the urban, 41 per cent; and the coastal, 34 per cent. These figures point out that the loans in the agricultural region were better distributed among the members than in the other three regions. The low percentage of borrowers in the urban region indicates that few members enjoyed the privilege of borrowing from the associations. These few obtained total loans very much larger than the total loans granted in the agricultural region, for the reason that large loans were given out to each borrower. In the case of the coastal region, the same condition existed as in the urban region. Loans in the coastal region were used principally in fishing enterprises. Agriculture has no place along the narrow coast of Antique Province where associations had been organized. The same is true with the associations on the coast of Iloilo and Capiz provinces.

The number of depositors in these associations were not very encouraging. In the agricultural region there were 223; the mountain, 81; the coastal, 62; and the urban, 13. There was a small number of depositors in the urban region, because there were banks available in Iloilo and also there were more opportunities to invest in business. The deposits in the rural credit associations are of two types. The *Cash Deposit Certificate* is a type of deposit payable on 30 days' notice and earns six per cent per annum. The *Time Deposit* is a type of deposit payable at a fixed term, say, one year, two years, or five years, etc., according to contract, and earns eight per cent per annum. Most deposits are made under the first type.

Powers of the association

Each rural credit association is a corporate body and acts as such under the Corporation Law (Act No. 1459). It is more than a mere association of members. It is in reality a village bank and a mutual-aid society. The final authority in the administration of the association rests with the stockholders who at their general meeting elect the members that compose its board of five directors who serve without pay. This board has complete control over the appointment, removal, and remuneration of the personnel, terms of purchase of farm supplies and sale of land, animals, house, etc., drawing of contracts and all other matters pertaining to the efficient functioning of the association. They report on the business transactions of the association at the annual stockholders' meeting. At this meeting future plans are discussed, the tentative budget, and the work for the following year outlined. The stockholders have the authority to amend the by-laws and to approve or reject memberships. The board is elected for a term of two years, but at a general meeting of stockholders any one of its members can be removed for misconduct or fraud before the expiration of his term. In a small association, one of the members of the board acts as secretary.

The operations in which an association may engage are fixed by law as follows:

(*a*) To open credit to its members, the loan obtained being invested in their farming operations;
(*b*) To open current accounts, with interest, with its members only;
(*c*) To obtain or buy seeds, fertilizers, chemical preparations for the extermination of plant pests, machinery, draft animals and farm implements, to be sold to the members of the association; and
(*d*) To obtain loans and receive deposits in order to increase the working capital.

The government is in charge of supervision, advisorship, and auditing in the associations. The rural credit agent as representative of the Director of the Bureau of Plant Industry instructs, criticizes, and guides each association in his district. The periodical visits and inspection by the agent constitute a real safe-guard of the affairs of the association.

PROBLEMS OF FINANCIAL ADMINISTRATION

Essentially, the rural credit association in Panay is a financial institution in the community where small farmers can be furnished with the little capital they need, instead of borrowing from the rapacious money lenders, who charge exorbitant interest. More than this, it is an institution for training people of limited ability and small means to help one another financially by co-operation.

Panay associations are among the many rural credit associations in the Philippines which do not adhere rigidly to the rules and regulations set down by the rural credit law. Oftentimes, these associations violate these rules and regulations not willfully, perhaps, but because it seemed necessary at times.

The granting of loans

The granting of loans is one of the principal difficulties in the administration of each association. The original capital of each association comes from two sources—from the subscribed shares of the members and from the membership fees. Once the association is organized its additional chief sources of capital are from the following: Interest earned on loans to members; Insular Government loan; and outside loans, such as those from the Philippine National Bank. Table 1 shows the total amount of loans granted by the Panay associations to its members; the total loans obtained as Insular aid; and the capital stock from 1919 to 1928. The number of associations, members, borrowers and depositors are also given.

TABLE 1

Summary of the financial reports of the rural credit associations in Panay by years

YEARS	ASSOCIATIONS	MEMBERS	BORROWERS	DEPOSITORS	ASSOCIATIONS INDEBTED TO RICE AND CORN FUND	CAPITAL STOCK	RICE AND CORN FUND LOANS	LOANS TO MEMBERS
	number	*number*	*number*	*number*	*number*	*pesos*	*pesos*	*pesos*
1919	56	6,633	3,233	83	40	98,505.00	193,500.00	286,055.81
1920	61	8,457	4,088	442	45	123,804.00	199,285.00	368,185.73
1921	63	9,052	4,186	773	47	131,209.80	199,880.00	410,168.65
1922	66	9,533	4,465	797	50	138,687.00	191,385.15	421,063.70
1923	67	9,494	4,862	689	53	146,584.00	237,834.67	490,400.68
1924	67	10,601	5,047	617	53	151,121.00	206,312.90	491,033.47
1925	67	10,302	4,937	521	50	153,645.00	176,821.60	460,669.38
1926	67	10,561	5,032	422	50	155,933.00	161,260.94	461,999.42
1927	67	10,655	4,946	368	49	156,609.00	149,955.42	461,835.09
1928	67	10,753	4,385	317	44	156,576.00	126,534.80	451,861.79
1929	67	No report [a]						

[a] Report not received at the Bureau of Plant Industry at the time of this writing.

How the funds of the associations were disposed of by the 67 associations is a long tale of irregularities. Favoritism and political interference were two forms of cancer that ate into the vitals of each association. The directors as the governing body of the association had the power to approve or disapprove all applications for loans; the result was that most loans were granted to relatives and political friends. In addition, the directors generally granted themselves larger loans than were granted to other members. A dishonest director, by conniving with his friends and relatives to sign the application blanks and voucher for him could secure a loan without his name appearing on the list of borrowers. Having confidence in the promise given by the director these "friends" signed their names ignorant of or ignoring the fact that they would be held legally responsible for the loan made. These cases of loans to directors were very common in many associations. To cite a specific case. A prominent man in a town, a former president, obtained several loans from his association by inducing friends to solicit loans for him. He did this by taking the application blanks and vouchers to the home of a friend of his own political party, and securing his signature and also those of his wife and grown children. The wife and children signed without knowing what the papers were. Loans were secured also on the blanks signed by his own family and tenants and servants. These loans long overdue with interest of years unpaid were reported by a rural credit agent to the Director of the Bureau of Agriculture. But up to 1929, neither principal nor interest had been paid. When the dishonest act of this man was discovered, some of the persons he had duped were not able to pay the loans which they had innocently but legally contracted. This man was unable to make proper restitution to those persons, as he had no means. The association ceased to function. This association had borrowed more than ₱2,000 from the Insular Government; at this present writing this debt had not been paid.

Section 11, Act 2508, states that, "no director shall vote on a loan requested by him for himself, for any member of his family, natural or by affinity, to the third degree, or applied for by any member of his family, natural or by affinity, to the third degree, nor on a loan requested by any person who owes a debt to him or to any member of his family; nor shall he become bondsman, surety, or indorser of any loan contracted with the association." Although loans granted to relatives were in violation of this section of the law, all the associations in Panay made these loans. In all municipalities many families are related. The members of the board of directors being human were inclined to favor relatives. In one association, 98 per cent of the members were blood relatives. Obviously, this association could make no loans without violating section 11 of Act 2508.

Securing loans from the association by agreeing to divide the amount borrowed with the person or persons signing the application blanks and vouchers and the person who worked for the approval of that application was another fraudulent practice. A striking instance may be given of a man who was on the board of the association and treasurer of an institution in a town. He had used the funds intrusted to him. To make up his default, he borrowed from the association. To get enough money to make good his theft from the institution of which he was treasurer, he forged the names of his wife, mother-in-law, and father-in-law and had them secure loans from the association and turn the money over to him. Had it not been for the leniency shown this man by the Central Office (Bureau of Agriculture) and the agreement of the "in-laws" to pay back the money to the association this man would have been brought to trial for forgery.

Section 5 of the law prohibits the granting of loans for any purpose except agriculture. This section was often violated by all the associations in Panay. In the application forms it would appear that the loan was to be used for planting rice, or for buying animals or for other uses connected with farming. But the money would not be used for the purposes stated, but for settling personal debts, for gambling, for buying materials for weaving, for building houses, for buying automobiles, for paying tuition fees for children in school or even for lending to others at usurious rates of interest. In one association, a man succeeded in obtaining from the funds of the association more than a thousand pesos under his own name and the names of other persons. This money, which at the time of writing has not been paid back, was used to purchase an automobile. According to the last annual report from this association, this man was still the president of the board of directors. In this association, as in others which permit similar practices, a majority of the members are *caciques* and usurers who favor this type of man for president. These men are the important or influential men of the association. They obtain the larger loans rather than the poorer members.

Collection of overdue loans

Enforcement of the collection of overdue loans is the greatest difficulty that a rural credit agent has to meet. The Jaro Association in Iloilo Province was the only association that had no overdue loans. When all members of the board of directors were overdue in their loans, a situation not unusual, collection was almost impossible. Very few borrowers ever pay without pressure being brought to bear. Notices sent by the board to the delinquents bring forth complaints and accusations rather than payment of debts to the association. Members claim that the directors themselves are delinquents and in a majority of cases this is true. When the president of the board had no unpaid loan, the delinquent borrowers were brought to court. But friends and relatives of the directors were usually favored.

In one association the president of the board sued several delinquent borrowers. The defendants complained that the president was not suing all borrowers with loans overdue and carried their complaints to a member of the House of Representatives who took up the quarrel and made the situation worse in that association..

Suing the delinquent borrowers seldom resulted in collections. The suits were often pigeon-holed for years in the court. Some of the justices of the peace were reluctant to take action in their courts against the persons sued. Many of them either advised the board to settle the cases amicably with the borrowers or acted on the cases extra-judicially. These actions of the justices of the peace were not fruitful of results. One association had 35 delinquent borrowers. In the early part of 1926 orders of execution by the court against them was given to the deputy sheriff who ignored the orders. Only in May, 1929, were some of the debts paid.

In many instances, associations lost money when members who had borrowed died leaving no property that could be attached for the debt. Cases were not uncommon when a borrower and his guarantors all became insolvent. In some cases, members of the board of directors who were responsible for the bad debts in the association died. Their successors showed no interest or concern when the agent suggested a way for recovering the association's money. The indifference of the board of directors in such cases is an illustration of the prevailing moral irresponsibility and lack of business ethics.

Rice and Corn Fund

The Rice and Corn Fund is the name of the law enacted in 1919 by the Philippine Legislature under Act No. 2518. By this law the Philippine Government appropriated ,one million pesos to promote cultivation of rice and corn, as there was a shortage of these crops during the critical times after the World War. The fund created by this law proved a blessing to all worthy rural credit associations in the Philippines. The one million pesos were loaned to the different associations at six per cent per annum, making it possible for the associations to earn four per cent on all loans made to their members at ten per cent per annum. These loans reverted to the fund after five years, according to Act 2518. This limitation, however, could be extended five years at the discretion of the legislature.

Of the three provinces comprising the island of Panay, Capiz had the largest loan from the Rice and Corn Fund in 1923. This loan amounted to ₱120,582.44. Iloilo had borrowed ₱85,283.34 and Antique ₱31,968.89. The Rice and Corn Fund was set aside to be used exclusively to aid the rural credit associations in the Philippines, but politics inevitably became a factor in its utilization. The associations which had the greater political influence got the amount of loan they desired from the fund. Various abuses and irregularities committed by the board of directors of each association could be directly associated with the loans that were granted to them from the Rice and Corn Fund.

One interesting case of a fraudulent act in the obtaining of money from this fund may be cited. One man, having found that the association would be able to borrow a large sum of money from the Insular Government, organized a society. He required, with no authority whatever, that all rural credit association members intending to borrow from the association should buy, after they received the loan, one or more shares of the calculated stock of his society; otherwise, he would not approve the application for a loan. The scheme worked well. Many members, mainly new ones, inexperienced in business, bought shares in his society. The number of shares he required these members to buy was made proportional to the loan applied for in the association. Hence, the larger the loan, the more shares were bought. The plan worked well for some years. The money accumulated by this fake society was invested in a private enterprise by this man before a rural credit agent finally exposed his scheme. But despite the exposure, this man was elected secretary of the board of directors which position he holds at the present writing. His election was questioned by the Bureau of Agriculture, but his influence among the members balked all efforts to separate him from the board.

CONCLUSIONS AND RECOMMENDATIONS

The working of the agricultural credit co-operative associations in the island of Panay, as seen and analyzed by the writer, shows that the system of farm credit in the Philippines is far from satisfactory.. The solution of the rural credit problems in Panay does not lie in the laws and regulations, but with the people who form the associations. The failures of many associations in Panay are the result of the wrong attitude of the people towards their government managed associations. They look upon them as not their own associations; and the capital they borrow is not their own but a God-given gift to them for their aid and enjoyment. They have no conception of personal responsibility in maintaining the capital of the society or in maintaining honesty in its transactions.

Co-operative credit associations could give better results if they would raise the standard of the qualifications for membership. Also they should be organized only in municipalities where they are needed. Dissemination of information and principles of rural credit co-operation can be achieved by a systematic campaign carried out by the employment of field agents who are experienced and educated along this line of work. Close supervision of all associations by these agents are needed.

Provincial capitals and towns that are largely industrial rather than agricultural are not suitable for agricultural credit co-operation.

To save the poor from the clutches of the usurers and the association from irregularities and abuses, the rural credit law should be remodeled so as to embrace a wider field of protective policy wherein persons wishing to engage in enterprises other than agriculture as commerce, fishing, weaving, pottery, distilleries, etc., could secure loans for the financing of their enterprises. Obviously, the present rural credit law needs a complete overhauling. Many of its impractical rules and regulations should be changed or abolished. The present law is too limited in its scope; also it does not provide for protection against irregularities and abuses.

A STUDY OF THE PHILIPPINE PONY AS FOUND IN MALVAR, TANAUAN, AND STO. TOMAS, BATANGAS[1]

MARTIN G. CALIÑGASAN

This investigation is, in general, a continuation of the work conducted by Lizaso (1921) and Mojares (1926)[2]. Specifically the objects of this work were: (*a*) To determine the sex, age, height, color, condition of horses, and kind of work done by them in Malvar, Tanauan, and Sto. Tomas, Batangas; (*b*) to ascertain the good points of conformation of these horses; and (*c*) to find out the common defects and unsoundnesses among them.

This investigation was carried out in the municipalities of Malvar, Tanauan, and Sto. Tomas, in Batangas Province. The work covered a period of nine months, from June, 1924, to February, 1925.

MATERIALS

Four hundred fifty-five horses were studied, of which 99 were from Malvar, 250 from Tanauan, and 106 from Sto. Tomas. Of these, 290 were males and 165 were females.

A score card as a guide in conducting the work and a wooden caliper for measuring the height of the animals were used in this investigation.

DISCUSSION OF RESULTS

Sex

Of the horses studied, 290 were males and 165 were females. (See table 1.) These figures represent a ratio of 1 female to 1.8 males. Only one male animal was found castrated. This indicates the general disinclination of Filipinos to castrate horses, the belief being that a castrated animal loses its spirit and courage in working.

TABLE 1

Showing distribution of sexes

MUNICIPALITY	MALE	FEMALE
Malvar	56	43
Tanauan	160*a*	90
Sto. Tomas	74	32
Total	290	165

a One horse is castrated.

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[1] Thesis presented for graduation 1925, with the degree of Bachelor of Agriculture from the College of Agriculture No. 324; Experiment Station contribution No. 695. Prepared in the Department of Animal Husbandry under the direction of Dr. Valente Villegas.

[2] LIZASO, JUAN. 1921. Observations on the Philippine horse. THE PHILIPPINE AGRICULTURIST **10**: 135–144.

MOJARES, URBANO A. 1926. A study of the Philippine pony as found in Lipa, Batangas. THE PHILIPPINE AGRICULTURIST **15**: 159–166.

Height

As may be seen in table 2, the height of horses studied varied from 111.8 to 137.2 cm. (44 to 54 in.). The greatest frequency fell at 124.5 cm. (49 in.) while the average height was 124.6 cm. (49.03 in.). From the same table, it may also be seen that the most frequent height is from 119.4 to 129.5 cm. (47 to 51 in.). Below the height of 118.1 cm. (46.5 in.) and above 132.1 cm. (52.0 in.) very few animals were found.

Lizaso (1921) states that the average height of Calamba, Los Baños, and Bay, Laguna, horses was 123.7 cm. (48.7 in.), while Mojares (1926) reported that the average height of Lipa, Batangas, horses was 128.3 cm. (Mojares made his investigation in 1924; the report was not published until 1926.) Compared with these heights, the average height, or 124.5 cm. (49.03 in.), of horses of Malvar, Tanauan, and Sto. Tomas is intermediate.

TABLE 2

Showing the frequency distribution of height

CLASS VALUE	FREQUENCY	FREQUENCY VALUE
inches		
44.0	1	44.00
44.5	1	44.50
45.0	2	90.00
45.5	2	91.00
46.0	3	230.00
46.5	14	651.00
47.0	26	1222.00
47.5	34	1615.00
48.0	61	2928.00
48.5	49	2376.50
49.0	66	3234.00
49.5	55	2722.50
50.0	42	2100.00
50.5	32	1616.00
51.0	28	1428.00
51.5	21	1081.50
52.0	13	676.00
52.5	1	52.50
53.0	1	53.00
53.5	0	0.00
54.0	1	54.00
Total	455	22309.50
Average		49.03

Color

From table 3, it is evident that the most common color is bay. This conforms with the observations made by Lizaso and Mojares. The order of frequency of the principal colors, after bay, in this study is: gray, buckskin, and roan. This order differs from Lizaso's results of colors in that bay led, followed by black, roan, and white; and from Mojares' in that he found the order bay, brown, gray, and roan. Cream color was found by the writer in 26 animals; black in 25; and chesnut in 21. Mouse color was observed in 12 animals, and brown in 10. Albino and piebald were rare colors.

TABLE 3

Showing the frequency distribution of color

COLOR	FREQUENCY
Bay	138
Gray	93
Buckskin	78
Roan	38
Cream	26
Black	25
Chestnut	21
Mouse color	12
Brown	10
Albino	3
Piebald	1
Total	455

Age

From table 4, it is apparent that the age of the horses studied varied from 2 to 24 years. The writer found the 24 year-old animal to be in good condition owing to good care and feeding given to him by the owner. The greatest frequency in age falls at 3 years, but animals 4, 5, 6, and 7 years of age were also common. The average age was 5.85 years, showing that the horses in this district were comparatively younger than those observed by Lizaso who found the average age to be 6.96, and by Mojares who found it to be 6.20 years.

The towns wherein these observations were made raise more horses than they need and so some are sold to buyers from other localities. It is customary for owners of horses to use them while they are still growing. This may acount for the relatively young age of the horses included in this study. The same reason probably holds true in the work of Lizaso and Mojares. Calamba, Los Baños, and Bay, Laguna, the region of Lizaso's study, buy horses from Batangas, while in Lipa, Batangas Province, the locality covered by Mojares, horses are raised and sold in other localities, but probably not to the extent that they are in the municipalities covered by this study.

TABLE 4

Showing frequency distribution of age[a]

CLASS VALUE	FREQUENCY	FREQUENCY VALUE
years		
2.0	12	24.0
2.5	21	52.5
3.0	73	219.0
3.5	26	91.0
4.0	44	176.0
4.5	15	67.5
5.0	57	285.0
5.5	8	44.0
6.0	51	306.0
6.5	5	32.5
7.0	38	266.0
7.5	10	75.0
8.0	29	262.0
8.5	3	25.5
9.0	9	81.0
9.5	1	9.5
10.0	14	140.0
10.5	0	0.0
11.0	9	99.0
11.5	0	0.0
12.0	6	72.0
12.5	1	12.5
13.0	13	169.0
13.5	0	0.0
14.0	4	56.0
14.5	0	0.0
15.0	5	75.0
15.5	0	0.0
16.0	0	0.0
16.5	0	0.0
17.0	0	0.0
17.5	0	0.0
18.0	0	0.0
18.5	0	0.0
19.0	0	0.0
19.5	0	0.0
20.0	0	0.0
20.5	0	0.0
21.0	0	0.0
21.5	0	0.0
22.0	0	0.0
22.5	0	0.0
23.0	0	0.0
23.5	0	0.0
24.0	1	24.0
Total	455	2654.0
Average		5.85 Yrs.

[a] Of the total number, the age of 113 horses was determined by certificates of registration, the others by the examination of their dentition.

Condition

Referring to table 5, it is clear that the majority of the animals studied were thin. This represents 47.91 per cent of the total. One hundred forty-two of the animals, or 31.21 per cent, were found to be medium in flesh, while only 95 horses, or 20.88 per cent, of the total were fat.

TABLE 5

Showing frequency distribution of condition of horses

CONDITION	NUMBER OF HORSES	PERCENTAGE
Fat..........	95	20.88
Medium......	142	31.21
Thin.........	218	47.91
Total.........	455	100.00

As given in table 6, of the 288 horses investigated, the majority, or 63.29 per cent of the total, were used for pulling carromatas. The second largest number, or 32.97 per cent of the total number, were pack horses. Only 17 animals, or 3.74 per cent, were used or raised for riding and racing.

TABLE 6

Showing frequency distribution of the kind of work

KIND OF WORK	NUMBER OF HORSES	PERCENTAGE
Carromata........	288	63.29
Packing..........	150	32.97
Riding and racing..	17	3.74
Total............	455	100.00

TABLE 7

Showing defects in conformation and unsoundnesses

DEFECTS AND UNSOUNDNESSES	NUMBER OF ANIMALS	PERCENTAGE
Dished-face	39	8.57
Roman nose	35	7.69
Overshot mouth	48	10.55
Undershot mouth	10	2.20
Broken incisors	13	2.86
Blind eyes	2	0.44
Collar sores	27	5.93
Scar on the knees	18	3.96
Base narrow	7	1.54
Base wide	26	5.71
Interfering (forelegs)	12	2.64
Sway back	9	1.98
Slab-sided	7	1.54
Coon-footed	18	3.96
Straight pastern	13	2.86
Cow-hocked	49	10.77
Drooping croup	15	3.30
Interfering (hindlegs)	20	4.40
Dragging	5	1.10
Forging	31	6.81
Bone spavin	8	1.75
Lymphangitis	1	0.22
Ridgling[a]	2	0.69
Canines in females[b]	15	9.09

[a] Computed from the total number of males, 290.

[b] Computed from the total number of females, 165.

Good points of conformation

Head. As a general rule, the head of the horses taken up in this study was of mediocre conformation. There were a few excellent heads, but, on the whole, they may be classed as plain. The carriage was fair and the size proportional to the body, but the contour and appearance of the face and forehead indicated a lack of intelligence.

Neck. The neck was fair. Some stallions of high spirit had a neck that was muscular and carried high, adding greatly to the style of the animal.

Fore quarters. In the majority of cases, the animals examined were strong in this point. They possessed a deep and fairly wide chest. The forelegs were generally of good quality and substance, although defective in placement.

Body. The body, as a general rule, showed capacity for feed, but lacked in width and muscularity of the back. In many instances, the body was short.

Hind quarters. While the ponies studied were superior in the fore quarters, the hind quarters were, as a general rule, poor in development. The croup was drooping, short, and rather narrow. As a whole, there was lack of muscling in the hind quarters. The legs possessed good quality and substance, but were poorly placed.

In view of the fact that the animals were all handled and used by their owners, very few individuals were found to behave badly or have a mean temper. So that these ponies may be regarded as generally of good disposition.

The action of the ponies was performed with activity and moderate speed, but irregular action was a common defect.

Almost all the animals examined were apparently able to live and work well under adverse conditions.

Defects in conformation and unsoundnesses

Referring to table 6, it may be seen that on the head the defects were: dished-face, which was found in 39 horses, or 8.57 per cent of the total; Roman nose, in 35 horses, or 7.69 per cent; overshot mouth, in 48 animals, or 10.55 per cent; undershot mouth, in 10 animals, or 2.20 per cent; broken incisors, in 13 animals, or 2.86 per cent; and blind in one eye in 2 horses, or 0.44 per cent.

On the neck, 27 animals, or 5.93 per cent of the total, were found to have collar sores caused by the use of ill-fitting collars.

Examining the fore quarters, the following defects were observed: Scars on both knees were found in 18 animals, or 3.96 per cent of the total; base narrow conformation of the legs in 7 animals, or 1.54 per cent; base wide on the legs, in 26 horses, or 5.71 per cent; and interfering of the forelegs in 12 individuals, or 2.64 per cent.

On the body, two defects were observed: Nine horses, or 1.98 per cent of the total, showed sway backs, and 7 horses, or 1.54 per cent, were slab-sided.

At the hind quarters, 15 animals, or 3.30 per cent of the total, exhibited drooping croups; 49 horses, or 10.77 per cent, were cow-hocked; and 20 animals, or 4.40 per cent, had hind-leg interference.

There were other defects of the legs. Eighteen individuals, or 3.96 per cent of the total, were found to be coon-footed; 13 horses, or 2.86 per cent, had straight pasterns, and 8 individuals, or 1.75 per cent, had bone spavins.

Thirty-one horses, or 6.81 per cent of the total number, were found to have the defect of forging, while 5 animals, or 1.10 per cent, had worn out toes, the effect of dragging. One horse was found to be affected with lymphangitis. Two stallions were observed to be ridglings. Fifteen mares, or 9.09 per cent of the total number of females, showed canines.

SUMMARY

1. Four hundred fifty-five horses were studied in the municipalities of Malvar, Tanauan, Sto. Tomas, in Batangas Province, of which 290 were males and 165 females.

2. The range of height was from 111.8 to 137.2 cm. (44 to 54 in.) the greatest frequency being at 124.5 cm. (49 in.). The average height was 124.5 cm. (49 in.).

3. Important colors predominated in the following order: bay, gray, buckskin, and roan. Colors such as black, cream, and chesnut were also common.

4. The age varied from 2 to 24 years. The most common age was 3 years, while the average was 5.85 years.

5. More horses were used for carromata pulling than for packing, riding, or racing.

6. In general, the horses were poor in condition.

7. In conformation, horses were generally well developed at the fore quarters. The legs possessed quality as well as substance, and the feet were well developed.

8. The horses exhibited wonderful stamina and endurance. They also showed a great deal of hardiness.

9. In disposition, the horses were tractable and easily handled.

10. The more common defects observed in the horses investigated were: dished face, Roman nose, overshot mouth, base-wide at the legs, cow-hocked, forging of the legs, and hind leg interference. There were a number of horses that showed the following defects: scars on both knees, broken incisors, undershot mouth, foreleg interference, sway back, base-narrow conformation of the legs, coon-footed, straight pastern, drooping croup, and bone spavin.

A MISNOMER IN THE USE OF THE TERM SOOTY MOLD[1]

The common name Sooty Mold, or its equivalent in French "Fumagines", designates a group of fungi characterized quite definitely by a profuse, densely black smudge on the host surface, leaf twig or fruit. The common name is very aptly applied and is ordinarily as definite as common names usually are.

It is difficult to give a scientific limitation of the Sooty Molds, but they all are probably of the Capnodiaceac. Perhaps not all Capnodiaceae can be properly called Sooty Molds.

A curious practice, certainly unwarranted, has arisen in some cases of designating members of the genus *Meliola* as Sooty Molds which they are not, because they do not possess the distinctive character of the Sooty Molds. Examples are afforded where *Meliola citricola* on Citrus or *Meliola arundinis* on sugar cane are referred to as Sooty Molds.

The origin of this misnomer is apparent since three early-known, widespread and common Sooty Molds were years ago designated as *Meliola citri*, *M. comellae* and *M. penzigi* and a large and widely circulated literature was built upon them. These three fungi, Capnodiaceous and probably of the genera *Capnodium* or *Limacinia* never would have been placed in the genus *Meliola* by any one who really knew *Meliola* and they have long been excluded from *Meliola*. Still the error thus started has in the past and does yet to some extent persist. No true member of the genus *Meliola* can properly be termed a Sooty Mold.

F. L. STEVENS,
Charles Fuller Baker Memorial
Professor (Plant Pathology, 1930-31)

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[1] General contribution from the College of Agriculture, No. 276. Received for publication, October 31, 1930.

A REVIEW: "JUDGING POULTRY FOR PRODUCTION"[1, 2]

A new book designed "to help bring about a better knowledge of how to judge poultry for vitality and production and to develop a sympathetic understanding of the relationship between those whose principal interest is commercial poultry and egg production and those who are responsible for the development of fancy poultry" has just been published. The authors, Professor James E. Rice, the "Dean of poultry husbandmen in the United States", Professor Goldan O. Hall, and Instructor Dean R. Marble, all members of the staff of the Department of Poultry Husbandry at Cornell University, have spared no effort in producing in *Judging Poultry for Production*, a manual that the great mass of poultrymen the world over will find useful.

The book is divided into four parts. The principles of production are covered in chapters I to XI; the practice of culling and selection is discussed in chapters XII to XVIII; the third part consists of chapters XIX to XXII; and the fourth part completes the book with a glossary, a bibliography, and a detailed index. The different items taken up throughout the book are discussed in detail. Published works that are of a controversial character are reviewed with an open mind. The science and art of poultry judging for production is undergoing rapid and continual changes, so the book is essentially an authoritative report of progress in the line of judging poultry for production, "to be continued as more facts become available, on which to draw conclusions." However, the authors present sufficient facts along this line to make the book of real value to those who raise chickens either for pleasure or for profit.

The first part of the book aims to explain the why and the "what-for" of the principal factors affecting production. The reader is made familiar with the A B C's of the production judge's alphabet, and he learns the "sign language of the bird". How to put these different principles into practice is covered in the second part. Culling the farm flock, selecting commercial layers and breeders, judging birds for meat production and judging eggs and baby chicks are all discussed in the clear and exact language of the true poultryman. An exposition on educational facilities, such as poultry judging schools, poultry judging contests, production shows, egg-laying contests and other organizations for poultry improvement make

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[1] Rice, James E., Goldan O. Hall and Dean R. Marble. 1930. Judging poultry for production. xii+425 p., 205 fig. New York: John Wiley & Sons.

[2] General contribution from the College of Agriculture No. 277. Received for publication October 6, 1930.

up the third part of the book. The fourth part comes under the title of general information. Readers of this book, especially those who are beginners in poultry judging for production, will find this part most useful in getting a thorough understanding of the many terms used in the book. The extensive bibliography will be of value not only to students, but also to investigators interested in this phase of poultry production.

The ideal of the authors which they commend to others is expressed in their creed which is here quoted:

> "To make the useful more beautiful and the beautiful more useful is the highest ideal of the breeder.
>
> "To combine properly into one harmonious whole the most useful with the most beautiful without sacrificing the ideals of either calls for the soundest science and the finest art of breeding.
>
> "Its accomplishment, therefore, is the ultimate measure of man's mastery of the forces of nature as applied to the improvement of living things."

That this creed has been closely followed is evident to the careful reader of the book. There are 425 pages in the book and 205 figures. The figures in themselves are most instructive as they portray many of the important points discussed in the book.

F. M. Fronda

Of the Department of Animal Husbandry.

EXCHANGE NOTES

There are extensive guano deposits in the Philippine Islands awaiting commercial exploitation. Numerous letters received from various parts of the country indicate a wide distribution of this fertilizer. To judge from information received from various sources, thousands of tons of bat guano remain practically untouched in the Philippine soil.

Guano consists of the excrement of birds, such as sea fowl, bats, etc., that inhabit coasts, islands, and caves. Through a gradual process of accumulation going on for years and years, this birds' refuse sometimes reaches considerable thickness. Containing nitrogenous and phosphatic compounds it is greatly valued as fertilizer. Guano may be used as manure in its natural form, and sometimes it is mixed with other ingredients to increase its commercial value.

Deposits of guano found in the Philippines are mostly bat guano, which are secreted in many caves scattered in different parts of this Archipelago. Bat guano is brown or grayish in color, and is granular in form, requiring an experienced eye to recognize it from sand. It sometimes contains as high as 9 per cent of nitrogen and 25 per cent of phosphoric acid. The composition of Philippine guano, however, is variable, some deposits giving a good percentage of these elements, while others are far below the average. Various deposits thus far excavated at different places have been found to be thoroughly satisfactory for commercial purposes.

A growing appreciation by leading farmers in the Islands of the importance of fertilizers in our agricultural industries led, in comparatively recent years, to the introduction of a small guano industry, to supply part of the growing demand for good manure. There are three Manila business firms that are buying guano which they use as the basic material for the manufacture of certain brands of commercial fertilizers. Their product is consumed almost wholly in the Philippine Islands, the best buyers being the sugar planters.

—*Commerce and Industry Journal* (Philippine Islands).

In 1929 there were delivered to the New York market more than 600,000,000 pounds of beef, 116,000,000 pounds of veal, over 470,000,000 pounds of pork, 174,000,000 pounds of lamb and mutton, 265,000,000 pounds of butter, nearly 200,000,000 pounds of dressed poultry, 10,000,000 pounds of live poultry, over 7,000,000 cases of eggs, over 50,000,000 pounds of cheese, about 1,500,000,000 quarts of cream and milk, and more than 200,000 carloads of fruits and vegetables, all produced in the United States.

Accurate records of the deliveries of grains, flours and cereals to this market are not available but they were in proportion to the enormous consumption of other foodstuffs.

Direct sunshine for hens in winter increases egg production and increases hatchability, according to experiments at the University of Wisconsin.

Glass substitutes, direct sunlight, irradiation with ultra-violet light, and cod-liver oil, were more efficient in getting eggs than leaving the glass windows in house all winter. Hatchability was increased in proportion to amount of direct sunlight received. Cod-liver oil and irradiation did not increase hatchability.

—*The Prairie Farmer.*

The University of Idaho has a Holstein purebred cow that recently made a new record for senior three-year-olds on a seven day test: 788.8 pounds of milk or a daily average of 112.6 pounds or 52½ quarts a day. It contained 18.9 pounds of fat or 23.6 pounds of butter.

—*California Cultivator.*

A $166,000 paper mill will be under way of construction after April the 15th in Richvale, California. This mill is to manufacture paper from rice straw, and was assured when a trust deed was filed through which money for construction was obtained. The trust deed is given by The Pacific Coast Pulp & Paper Corporation to The Service Investment Company, Ltd. This announcement is of unusual interest to the rice industry because rice straw is to be the main constituent of the paper to be manufactured.

—*The Rice Journal.*

Covering a fortnight's residence at the Queensland Agricultural College, at Gatton, and including both practical and theoretical training, the third of a series of schools of instruction for farmers and their sons, interested in the breeding, feeding, and management of pigs, concluded early last month. * * *

This year's school was marked by even keener interest and application, and the students as a body reported that they had thoroughly enjoyed and much appreciated the opportunity provided of attending such an important course of training.

—*Queensland Agricultural Journal.*

COLLEGE AND ALUMNI NOTES

Doctor Stevens, Baker Memorial Professor, addressed the student convocation of the University of the Philippines, in the Little Theater, Manila, on November 12. The subject of the address was "Some Unsolved Mystery Stories".

The fifth of the series of semi-popular lectures by Doctor Stevens was given in Agronomy Lecture Hall on the evening of November 5. The subject was "Plant Disease Migration, National and International." Under Doctor Stevens' presentation there were thrills as well as much interesting information in the lecture.

News has been received of the death of Feliciano C. Nuestro of the Class of 1931 from typhoid fever on November 1. Mr. Nuestro was a graduate of the Indang Farm School and had been a student in this College since 1922. He had worked his way part of the time, occupying the position of student assistant in Agricultural Chemistry from January, 1928, to June, 1930. Mr. Nuestro recently completed all the requirements for the degree of Bachelor of Agriculture, and the faculty of the College approved his graduation at its last meeting on October 28. Mr. Nuestro was a conscientious worker, and both the institution and the country have lost with his death a very promising young man.

Maximo M. Molina of the Class of 1931 died of typhoid fever with complication of malaria at his home in Caloocan, Rizal, on November 8, 1930. Mr. Molina was a graduate of the Manila East High School and came to the College in June, 1927. He left the Campus on August 10 on leave of absence on account of illness. Mr. Molina was a diligent student and a conscientious worker. His many friends will mourn his loss.

Mr. Leopoldo Villanueva, formerly assistant in Agricultural Chemistry, returned to the College October 20, 1930. After spending two years in the United States as a pensionado of the Philippine Government, Mr. Villanueva obtained the degree of M. S. from the Audubon Sugar School, Louisiana State University. He has been recommended for position as instructor in the Department of Chemistry.

Mr. Getulio Guanzon, assistant in Sugar Technology and now a fellow of the University of the Philippines, obtained the M. S. degree from the Audubon Sugar School, Louisiana State University, in August, 1930. Mr. Guanzon is now taking courses leading to the Ph. D. degree in the University of Minnesota.

The Cine Makiling Company, in co-operation with the Philippine Theatrical Enterprises Co., operates every Friday evening a moving-talking picture, instead of the old silent movies. The inaugural talkie program was on October 18 and presented Ramon Novarro in "Devil May Care".

Mr. Arsenio Luz, Director-General of the Philippine Carnival Association, has announced that the annual carnival will be held this year from January 31 to February 15. While the Carnival will provide much fun there will also be fine exhibits showing the industries and commerce of the Philippines.

The following students received marks of distinction for work done in the College of Agriculture during the First Semester, academic year, 1930-31:

Only students carrying regular loads (minimum of 15 units for working students and 20 units for regular students) were considered.

The average rating was computed by multiplying the final rating obtained by the student in a course by the number of units carried by the course and dividing the sum of the products by the total number of units carried by the student.

Names	Units carried	Points
1. Oliveros, Salvador	19	1.31
2. Villas, Trinidad	15	1.33
3. Komkris, Thuan	22	1.90
4. Chan, Felicidad (Miss)	22	1.95
5. Caguicla, Elena (Miss)	22	2.09

The following students were recommended for graduation to the University Council by the College Faculty in session, May 28, and October 28, 1930:

FOR MAY 28, 1930:

a. Bachelor of Agriculture:

1. Eugenio A. Agudo (Ivana, Batanes).
2. Abundio E. Mojica (Indang, Cavite).
3. Simon L. Perez (Ormoc, Leyte).
4. Manuel Tuya (Tigbauan, Iloilo).

b. Bachelor of Science in Agriculture:

1. Felix D. Enrile (Baliuag, Bulacan).
2. Sotero P. Lantican, B. Agr. '26 (Los Baños, Laguna).
3. José A. Serrano, B. Agr. '27 (Peñaranda, Nueva Ecija).

c. Bachelor of Science in Sugar Technology:

1. Manuel L. Hollero (Jaro, Iloilo).

d. For the Certificate in Agricultural Education:

1. Lorenzo Goco, B.S.A. '23 (Malabon, Rizal).
2. Servillano Gutierrez, B.S.A. '29 (San Carlos, Pangasinan).

FOR OCTOBER 28, 1930:

a. Bachelor of Agriculture:

1. Salvador J. Ascalon (Victorias, Occidental Negros).
2. Marcelino B. Garcia (San Carlos, Pangasinan).
3. Feliciano C. Nuestro (Indang, Cavite). (Died, November 1.)
4. Antonio Pedroso (Janiuay, Iloilo).

b. Bachelor of Science in Agriculture:

1. Silvio A. Decena (Calamba, Laguna).
2. Felix S. Gamo (Paco, Manila).
3. Andrés M. Nono (Cuyapo, Nueva Ecija).

c. Bachelor of Science in Sugar Technology:

1. Fernando M. Fernandez (San Roque, Cavite).
2. Cornelio G. Lemoncito (Hinigaran, Occidental Negros).

Loyalty Day, October 10, was observed with the usual features. In the Students' Procession, outside of the N. G. Veterans, some twenty strong, and the Cadets, the Ranchers' Club, the Associated Women Students, and the Rural High School Girls were the effective sections. One missed many of the College organizations. This is to be regretted. The original plan of this procession was to give these organizations a chance to show their originality and give life and color to a real College affair which it was hoped would become the "big thing" on Loyalty Day.

The principal speaker, Major General Paul B. Malone, was introduced by President Palma. Miss Mamerta Manahan and Miss Iluminada Torres, accompanied by Dr. D. Aquino on the violin, sang "Sleep, Beloved, Sleep". Mariano Pamintuan, Raul Arana, Felino Manzano, and José Quintos sang "Down in the Cane Brakes" with banjo accompaniment. "Hail College Dear," "Philippines My Philippines", and "America" were sung by the audience under direction of Miss Katherine Turner.

There was the usual faculty luncheon at Molawin Hall.

In the afternoon, after an exciting baseball game, students *vs.* faculty with the students victors, there was the review of Cadets by Major A. Garfinkel, Commandant Cadet Corps, University of the Philippines. There was also a Drill Competition for the Brias Roxas Cup.

In the evening the Mimics presented a program of two parts. Part I was a play, "The Husband of Mrs. Cruz," by Dr. Vidal Tan of the College of Liberal Arts. The cast was:

CAST IN ORDER OF APPEARANCE

Don Pedro	Valeriano Revicencio
Doña Mameng	Basunie Saropie
Rodolfo	Pedro Lorenzo
Clara	Miguel de Guzman
Juan	Sam Sen Sakol
Mang Cario	Onofre Casupang
Bruño	Ruperto Ami
Bill Collector, Press Representative	Juan Baltazar
Doctor, Sheriff	
Guard, Leader, Photographer	Lino Salazar

Part II opened with a Visayan Dance by:

Elsa Roa
Teofista Ocampo
Salud Lawas
Soledad Marfori
Honorio Ylizarde
Salvador Ascalon
Pedro Yatar
Raul Arana

With the sounding of "First Call" back of scenes by Mariano Perlas, the carrying in of colors followed by the chorus:

Acelo Badelles
Gabriel Flores
Praxedio Golez
José Quintos
Martin Rosell
Sabas Tangco
Domingo Tugade
Honorio Ylizarde

in uniform, wearing campaign hats, carrying knapsacks and guns marching in singing "Tipperary" the audience was back in the days of 1914-'18. "Smiles" was sung with equal vigor. Then the chorus marched off stage singing "Tipperary". "Till We Meet Again" was sung by three soldier lovers to their sweethearts. "Assembly" was sounded by the bugler, again the colors were carried in. Again the soldier boys marched in singing, this time "Over There". This song was followed by "Katy" and "Long, Long Trail".

"Hail, College Dear", "Philippines, My Philippines", and "America" by all closed a program that had given the audience a real *reminiscent* thrill.

The Loyalty Day program closed the season for the Mimics—a season on which the Director, Miss Anne Cole, and the Club can be heartily congratulated.

The Mimics will continue their weekly meetings during the second semester, devoting the time to study of presenting plays.

Under direction of Miss Hazel Reed, instructor U. P. Rural High School, the Makiling School gave a Christmas Program on December 18.

The Senior students in Sugar Technology are taking their Sugar Mill Practice B in the following centrals:

1.	Deomano, Francisco	Tarlac Central
2.	Ebreo, Igmedio	Bacolod-Murcia Milling Co.
3.	Gomeri, Julian	La Carlota, Negros Occ.
4.	Gomez, Francisco	Baratac-Nuevo, Iloilo, Panay
5.	Munsalud, Manuel	Pampanga Sugar Development Co.
6.	Pañgan, Wenceslao	Tarlac Central
7.	Ramos, Cayetano	La Carlota, Negros Occ.
8.	Santos, Amado	Don Pedro, Nasugbu, Batangas
9.	Sason, Marcelino	Pampanga Sugar Development Co.

The U. P. Rural High School girls sold more than ₱30 worth of flowers on All Saints' Day. There are 14 girls in the class and no special plans had been made to supply flowers for the day.

Enrollment of students in the College of Agriculture by classes, academic year 1930-1931

CLASSES	NUMBER	
	1ST SEMESTER	2ND SEMESTER
1. Freshmen	241	180
2. Sophomores	218	209
3. Juniors	119	118
4. Seniors	82	68
5. Supplementary Curriculum Students	20	19
6. Graduate Students	12	12
7. Special Post Graduate Student	0	1
8. Special Students	16	16
9. Veterinary Students	79	72
10. Forestry Students	2	2
11. U. P. R. H. S. Students	31	21
Total	820	718

The U. P. Rural High School has a full set of officers and the student government is functioning under a regularly adopted constitution.

SPECIALIZATION IN SCIENCE[1]

In the organic world it is the generalized type which gives rise to higher forms while extreme specialization means an end of progress. To illustrate from the field of botany: the mosses have been called an evolutionary failure for, although they have adopted a thousand forms, these all are too highly specialized to allow of really important advance. In the whole moss class there is a clinging to certain particular features—no freedom to produce or even to suggest anything non-moss like. . . .

Among animals, also, specialization stops progress. Neither the intelligent and betrunked elephant tribe, nor the swift-footed, one-toed horse, nor the cunning members of the wolf and dog family with their great body specialization and highly developed sense organs produced the "lords of creation". Rather was it some simple creature with primitive hands and feet and jaws which began that great advance leading by one path to the grinning chimpanzee and ferocious gorilla or, by another turn, past a long series of human-beasts to present-day man. Here, as always, the specialized types early reached a limit beyond which they could not go while generalized forms retained the power to advance. . . .

It is a fashion just now of newspaper columnists to make fun of the many specialties in medicine; but are these any narrower than the enclosed and cultivated fields in the general sciences? As a botanist I must associate not with other botanists but with plant physiologists, plant ecologists, geneticists, biometricians, phycologists, mycologists and phytopathologists. Perhaps this specialization is not so extreme as it sounds; it may be that these worthy men of science are really broader than they like to appear. But our universities seem not to be working for breadth. Many professors, although themselves broadly trained, permit students to give all their time to a small field of study. I suggest that embryonic and larval scientists be encouraged to cultivate also their "minor" subjects. . . .

Specialization has come to stay. The family physician, the old-fashioned naturalist and the general students of physical sciences give way to those who confine their work to a particular and narrow field. Should not these specialists, however, have a solid foundation, a broad background, for their individual studies? Should the chemist be merely a chemist or should he have some knowledge of other branches of science? Shall the geologist be a geologist and nothing more? Will the physicist be a better or a poorer physicist if he knows some chemistry? Is it not true that he who neglects broad fundamentals, however proficient in some specialty, may fumble long and never find the key which opens the door of opportunity?

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[1] Condensed from the address of Professor Francis Ramaley, the retiring president of the Southwestern Division of the American Association for the Advancement of Science, Tucson, Arizona, April 23, 1930. These extracts are reprinted from *Science.*

Perhaps it is not altogether the fault of the university professor that his graduates lack the broad training which I claim to be so important. Personally, I find it difficult to make students, whether under-graduates or graduates, elect courses outside their major department. They become acquainted with the general facts of their own science and with the instructors and their methods; they fear to set out upon an unknown road lest they be not able to travel it in safety. These observations refer not so much to the "weak brothers", for they may try a new subject hoping that it will be easy, but they point rather to the so-called "good" students who have done well yet are such timid souls that they shrink from the untried. I find very little zest for intellectual adventure among the "flaming youth" of to-day who like best the familiar scenes and who do not care to seek out that which lies beyond accustomed limits.

Since specialization is necessary, how may the ills of over-specialization be minimized? If workers in different sciences are brought together in one organization each is broadened by contact with others. There may be mutual help for those too narrowly trained, whether employed in a university or an endowed research institution or in an industrial plant. Young persons entering upon a scientific career need to be reminded of this great advantage in working with others. The solitary science worker lacking the stimulating influence of companionship in research has a hard struggle, and especially hard if his interests are greatly circumscribed. The annual gatherings of societies are of high value. We older folk know this from experience but youngsters need to be told. This meeting of the Southwestern Division of the American Association for the Advancement of Science brings before us many problems and achievements of our fellow laborers in other fields. It gives us breadth of vision and keeps us from thinking too highly of ourselves and of our own specialties.

It has been my attempt to show the need of breadth of learning and the danger of one-sidedness. But let me not be misunderstood! I know and you know that the great scientific advances of the future will come from the work of the specialist. Yet it seems reasonable to expect that the specialist with a wide background of scientific knowledge will achieve most. Those of us now in the harness may well urge upon the rising generation a longer scholastic preparation and a more generous grounding in basic science. May these neophytes, as they advance in their studies and in their professional careers, retain a sympathetic interest in all knowledge even while they press forward in their own straight and narrow path!

INFLUENCE OF LIGHT UPON GROWTH AND DEVELOPMENT OF PLANTS WITH SPECIAL REFERENCE TO THE COMPARATIVE EFFECTS OF THE MORNING LIGHT AND OF THE AFTERNOON LIGHT[1]

R. B. ESPINO AND F. PANTALEON
Of the Department of Plant Physiology

WITH SIX TEXT FIGURES

INTRODUCTION

Light is such a decidedly important factor in human, animal, and plant life that the amount of published work on it is enormous. Examination of the literature on the subject in connection with plants alone shows that very many aspects have been studied. The literature includes, among other topics, the effects of light rays of different wave lengths on plant growth and development and on its various forms of physical and metabolic processes. The word, "photoperiodism" has even been coined to designate the responses of plants to length of day, and an arbitrary classification of plants with respect to light requirement has been proposed, such as, (*a*) short-day plants, (*b*) long-day plants, and (*c*) ever-blooming plants. Also, results of micro-chemical and morphological studies of effect of light on plants are found in the literature.

According to Palladin (1923), it is now recognized that light is not confined to the photosynthesis of carbohydrate from CO_2 and H_2O. "Very many oxidations, reductions, hydrolyses, polymerizations and condensations are effected by light."

The effects of strong and diffused light on plant assimilation was extensively studied by Muntz (1913). At first, for a number of years, he made field observations. He noticed that alfalfa produced less material per square meter in 1911, a summer unusually free from clouds, than in 1910, when rain was frequent and cloudy skies prevailed.

That he might give the plants the same amount of water, Muntz made further observations in the laboratory. He determined the dry matter of the plants, and found that the results of his laboratory experiments "seem to confirm those of the observations made in the field". He was led to the conclusion that "assimilation is limited more by the proportion of carbon dioxide available than by the intensity of the light".

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[1] Experiment Station contribution No. 700. The experimental work was done by the students in Plant Nutrition under the authors' direction and direct supervision. This paper was read before the Los Baños Biological Club, November 20, 1930. Received for publication, November 25, 1930.

But, Liubimenko (1915) found that in heliophilous plants, (plants that thrive best in bright sunshine) the rate of CO_2 decomposition increases continuously with increase in light intensity. This author, however, found also that for heliophobous plants (plants that thrive best in shade or in regions of low light intensity) there exists an optimum light intensity and any increase beyond this optimum results in a decrease in the rate of CO_2 decomposition.

Combes (1910) also studied the effects of strong light and diffused light on plants and came to the conclusion that "strong light in general induces the accumulation of elaborated materials in the storage parts of plants, such as rhizomes, tubers, fruits, etc., while more diffused light tends to the utilization of the nutritive materials and as a consequence increases the growth of such organs as leaves, herbaceous stems, etc.".

The formation of chlorophyll is also influenced by light. Of course, it is now a well established fact that light is necessary but not essential for the formation of chlorophyll (Palladin, 1923). Liubimenko (1915) was able to show that heliophobous plants are richer in chlorophyll than are the heliophilous plants. He states that within certain limits, the greater the amount of light and the higher the temperature, the smaller is the amount of chlorophyll formed by the plant.

The form and position of plants are likewise influenced by light. Wiesner (1911) basing conclusions on results of his own studies, states that plants, especially those well adapted to growing in direct sunshine, are characterized by leaves and other green parts so placed as not to receive the light at its highest intensities, but at only the lower intensities. Norma Pfeiffer (1926) found that there is a period of exposure for each form of plant. Beyond this exposure, additional duration was found to be ineffective in producing differentiated tissue, or increased height. It is now known beyond question that the lodging of grain plants which was formerly attributed to a deficiency of H_2SiO_3 in the soil, is the result of insufficient illumination (Palladin, 1923).

MacDougal (1915) basing conclusions on results of his studies, claims "that light does not exercise a flat or invariable effect on growth". From his studies, MacDougal was able to state further "that light and temperature in lesser degree are seen to exercise a totalized releasing effect on growth coincident with reduced acidity and increase hydration to a certain limit". Beyond this, however, growth is checked.

The growth of the date palm was found by Mason (1925) to be inhibited by intense sunlight of desert regions. This author observed that growth in absence of direct sunlight is apparently synchronous with the closing of the stomata, checking of transpiration, and increased turgescence in the meristematic tissues.

Even the amount of dry matter in a plant is influenced by time of the day, or by illumination. Miller (1924) found that in the case of both corn and the sorghums, the amount of dry matter in the leaves begins to increase from 4:00 to 6:00 a. m., reaching a maximum somewhere between 2:00 to 6:00 p. m. Then, gradually the amount diminishes until daylight of the following day.

The effects of light on growth were further observed by Garner and Allard (1920). These authors found that, in general, the extent of growth was proportional to the length of the daily exposure. Under the shorter exposures the plants were rather chlorotic, shorter and less stocky. The shaded plants showed the typical effects of reduced light intensity commonly observed, such as slender stems with slightly broader leaves, and with a reduced production of dry matter. These authors found also that certain plants attain the flowering and fruiting stages only when the day, or the exposure to light is of a certain length. As the length of the day is increased, the short-day plants become more vegetative. On the other hand, the plants that require a relatively longer day or longer exposure to sunlight become weakly vegetative when exposed to a day of a shorter illumination.

Yoshii (1926) also made further studies on the effects on plants of periods of different lengths of exposure to light. He studied different plants, particularly rice. From his studies, Yoshii arrived at the conclusion that the short-day test plants he studied came "into flower only when the length of the day falls within certain limits". This finding confirms those of many other investigators. Yoshii, however, observed that in addition to the arbitrarily considered short-day plants, and the long-day plants, there is another group in which the plants were "nearly or entirely indifferent to photoperiod, but are affected for the time of flowering by other factors". This same author observed also that "the rate of growth is proportional to the length of daily exposure to light".

From the study of the mass of literature on light and plant growth, two things seem apparent; namely, (*a*) that studies on light and its influence on plants in the Philippines are still very limited, and (*b*) that the effects of the morning light and the afternoon light upon growth and development of plants grown under Philippine conditions, have not yet been experimentally compared. Thus, it was deemed of interest and of importance to make this study, the results from which are here presented; the main objects being to contribute to the very limited Philippine literature (*a*) on light duration and light intensity and their influence on plant growth and development; and (*b*) on the comparative effects of the morning sunlight and the afternoon sunlight. Incidentally, the effects of shade, (or moderate light intensity) was compared with effects of the intense sunlight.

This study was conducted in the Department of Plant Physiology of the College of Agriculture during the latter half of the year 1929 and the early part of 1930.

MATERIALS, METHODS, AND RESULTS

The plants

Five different kinds of plants were employed in this study. They were:

1. Rice, *Oryza sativa* L.
2. Maize, *Zea mays* L.
3. Alicbangon, *Commelina benghalensis* L.
4. Cucharitas, *Alternanthera versicolor* Regel.
5. Pechay, *Brassica juncea* (L.) Cross.

The soil

The solid culture medium employed in all the cultures was the ordinary garden clay-loam soil. The soil was obtained from the Experimental Garden of the Department of Plant Physiology. It was pulverized, sieved and thoroughly mixed before using. About seven kilograms of the soil was used in each culture. Every pot in a set contained the same amount of the soil.

General precautions observed

Plants of about similar appearance and stage of development were selected for use in each set of cultures. The plants received uniform treatment and care as to water, amount of soil, weeding, cultivation of the soil in pots, drainage, and other items. With respect to light—in intensity and in duration of exposure,—the plants received different treatment. Some cultures were kept in the shade. Others were exposed directly to the sun. Of the cultures that received the direct sunlight, some were exposed during the entire day, 6:00 a. m. to 6:00 p. m.; some, only during the morning hours 6:00 a. m. to 12:00 M., and still others received only the afternoon sunlight, 12:00 M. to 6:00 p. m. Each set of cultures lasted for 25 or 30 days, except the first trial in which the cultures were allowed to grow older for exposition purposes. When not exposed to light the cultures were kept in darkness.

Description of the criteria of results

The experimental data were gathered as follows:

Height of top, (or height of plant). At the time of harvest the tops from each culture in a lump or bunch were measured in centimeters from the point of connection of the top to the root to the highest leaf tip. This is the *height of top*, and is applied to the cultures which were started from seeds.

In case the cultures were started from cuttings the *height of plant* was obtained by subtracting the *initial height* from the *height at harvest*. The result is here called *growth increment*. In other words, the data that are really of value for comparative purposes in connection with the influence of light intensity and duration are those under the last criterion, the *growth increment*.

Length of root. The data under this criterion were gathered in centimeters by measuring the length of the bunch of roots obtained from each culture from the base of the stem to the tip of the longest root.

Dry weight of top. At the time of harvest the tops from each culture were severed from the roots, dried in an electric oven to a constant weight, weighed, and the data are in grams.

Dry weight of root. The data under this criterion were obtained in a similar manner as those of the top, except that after drying, the roots were weighed instead of the tops. The data are also expressed in grams.

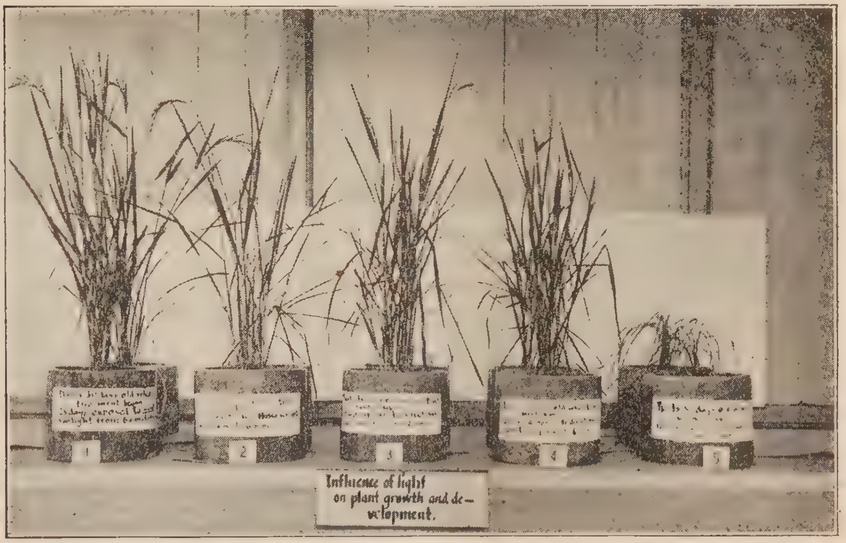

Fig. 1.—Rice plants 30 days old when treatment began and 25 days experimental period.
(1) direct sunlight 6:00 a. m. to 6:00 p. m.; (2) diffused light 6:00 a. m. to 6:00 p. m.; (3) mornings unlight 6:00 a. m. to 12:00 M.; (4) afternoon sunlight 12:00 M. to 6:00 p. m., and (5) plants placed in darkness.

Diameter of stalk. The stalks, at their largest point, of the three plants in each culture were laid side by side on the table, and the total diameter was measured in centimeters with a meter stick.

Number of leaves. As this criterion indicates, the leaves of the plants in each culture were counted.

Area of leaves. The length and the maximum width of each leaf in a culture were measured in centimeters. Then, the length and the width were multiplied; the result is the approximate area of that leaf. The approximate areas of all the leaves obtained from each culture were added together. The sum was called *area of leaves.*

External appearance of plants. At the time of harvest the plants in each culture were examined carefully for anything striking in appearance or any peculiarity. The results of this observation were briefly recorded as shown in the tables.

The cultures and results

Rice plant. Two sets of cultures of rice were tried. The first set was started when the plants were 30 days old and the comparative treatments were continued for 25 days. Each culture was run in duplicate. The comparative tests were made under the following conditions:

1. Exposed to direct sunlight from 6:00 a. m. to 6:00 p. m.
2. Esposed to diffused light from 6:00 a. m. to 6:00 p. m.
3. Esposed to morning light from 6:00 a. m. to 12:00 M.
4. Exposed to afternoon sunlight from 12:00 M. to 6:00 p. m.
5. Placed in darkness.

This set was run for the College Exposition held in October, 1929, and the beautiful comparative results obtained from the cultures (see fig. 1) was the incentive for the similar experiments that were subsequently conducted. The plants were photographed but were not harvested, so that no quantitative data can be presented in this paper.

TABLE 1

Growth and development of rice plants, Oryza sativa, as influenced by light. (Average of duplicate cultures; three plants in each culture.)

CULTURE NO.	DURATION OF EXPOSURE	HEIGHT OF TOP	LENGTH OF ROOT	DRY WEIGHT		EXTERNAL APPEARANCE OF PLANTS
				Top	Root	
		cm.	*cm.*	*grams*	*grams*	
1	Afternoon light 12 M.—6:00 p.m.	32 3	10.5	0.56	0.17	Plants rather weak and stunted in growth. Leaves chlorotic short, narrow and thin.
2	Morning light 6:00 a.m.—12 M.	51.8	12.8	2.67	0.53	Similar to plants in culture 3.
3	Diffused light 6:00 a.m.—6:00 p.m.	57.3	22.2	2.49	0.79	Plants rather slender, with long narrow light green leaves. Few tillers produced.
4	Direct sunlight 6:00 a.m.—6:00 p.m.	67.0	30.4	7.38	1.87	Plants healthy with broad dark green leaves. Heavy tillers.

Another set of cultures of rice was run. This time, the plants were started from seeds on November 27, 1929. The cultures were run in duplicate; three plants in each culture. Fifteen days after the appearance of the young plants from the seeds, the different exposures to sunlight were made, as follows:

1. Exposed to afternoon sunlight, 12:00 M. to 6:00 p. m.
2. Exposed to morning sunlight, 6:00 a. m. to 12:00 M.
3. Exposed to diffused light from 6:00 a. m. to 6:00 p. m.
4. Exposed to direct sunlight from 6:00 a. m. to 6:00 p. m.

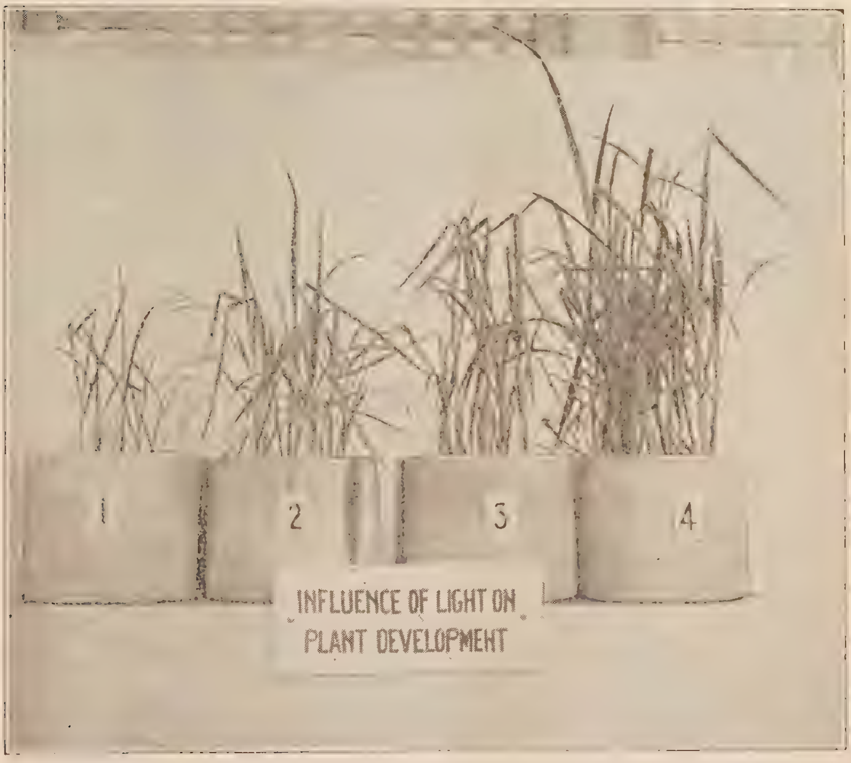

Fig. 2.—Rice plants, started from seeds; 15 days old when treatment began; 45 days old as shown in the figure.
(1) exposed to afternoon sunlight, 12:00 M. to 6:00 p. m.; (2) morning sunlight, 6:00 a. m. to 12:00 M.; (3) diffused light, 6:00 a. m. to 6:00 p. m.; and (4) direct sunlight, 6:00 a. m. to 6:00 p. m.

On January 16, 1930, when the plants had received 30 days of treatment, the cultures were harvested. Numerical data were gathered under each of the following criteria: (*a*) height of top, (*b*) length of root, (*c*) dry weight of top, and (*d*) dry weight of root. Before harvesting, the plants in each culture were observed, and all the cultures were afterwards photographed (see fig. 2). The data obtained are recorded in table 1.

Maize plants. The cultures with maize plants were also made in two sets. The first set, consisting of 5 duplicate cultures, 3 plants in each culture, was run for the College Exposition held in October, 1929. The plants were started from seeds and placed under different light exposures for 25 days. The conditions of exposure were as follows:

1. Direct sunlight from 6:00 a. m. to 6:00 p. m.
2. Diffused light from 6:00 a. m. to 6:00 p. m.
3. Afternoon sunlight, 12:00 M. to 6:00 p. m.
4. Morning sunlight, 6:00 a. m. to 12:00 M.
5. In darkness.

The cultures were harvested on October 28, 1929, but before harvesting they were photographed, (see fig. 3). The experimental data obtained are under the following criteria: (*a*) height of plant, (*b*) diameter of culms, (*c*) number of leaves, and (*d*) dry weight of top, and are presented in table 2.

TABLE 2

Growth and development of young maize plants as influenced by light.
(Average of two cultures, 3 plants in each culture.)

CULTURE NO.	DURATION OF EXPOSURE	HEIGHT OF PLANT	DIAMETER OF CULM	NUMBER OF LEAVES	DRY WEIGHT OF TOP
		cm.	*cm.*		*grams*
1	Direct sunlight 6:00 a.m.—6:00 p.m.	246.7	3.8	25	7.15
2	Diffused light 6:00 a.m.—6:00 p.m.	175.0	1.3	24	2.27
3	Afternoon light 12:00 M.—6:00 p.m.	147.3	1.2	22	2.02
4	Morning light 6:00 a.m.—12:00 M.	197.8	3.0	26	3.33
5	In darkness	died			

The second set of cultures of maize plants was also started from seeds on January 20, 1930. The exposures to the different light intensities and duration were started when the plants were 7 days old. Harvest was made on February 26, 1930. The cultures received the following exposures to light:

1. Direct sunlight from 6:00 a. m. to 6:00 p. m.
2. Diffused light from 6:00 a. m. to 6:00 p. m.
3. Morning sunlight, 6:00 a. m. to 12:00 M.
4. Afternoon sunlight, 12:00 M. to 6:00 p. m.

The experimental data gathered at the time of harvest are recorded in table 3 under the following criteria: (*a*) height of plant, (*b*) length of root, (*c*) dry weight of top, (*d*) dry weight of root, and (*e*) number of leaves.

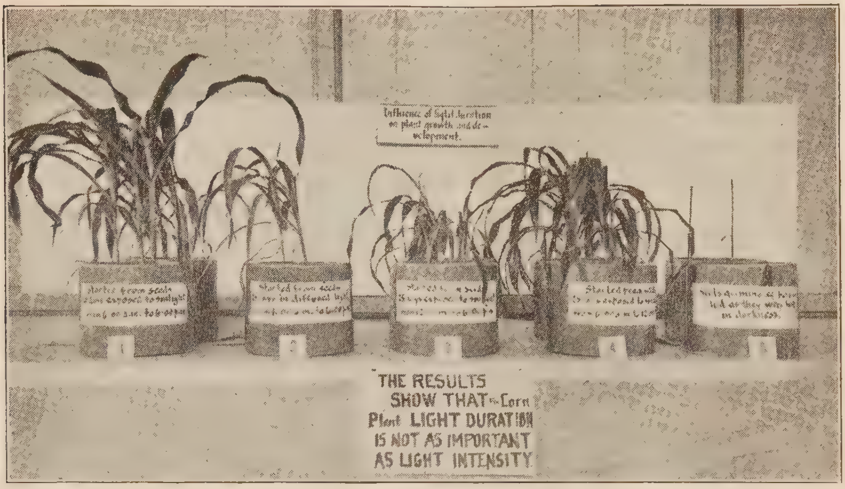
Influence of light duration on plant growth and development.
THE RESULTS SHOW THAT in Corn Plant LIGHT DURATION IS NOT AS IMPORTANT AS LIGHT INTENSITY

Fig. 3.—Maize plants, started from seeds, now 25 days old: (1) exposed to direct sunlight, 6:00 a. m. to 6:00 p. m.; (2) diffused light, 6:00 a. m. to 6:00 p. m.; (3) afternoon sunlight, 12:00 M. to 6:00 p. m.; (4) morning sunlight, 6:00 a. m. to 12:00 M., and (5) in darkness.

TABLE 3

Growth and development of maize plant, Zea mays as influenced by light. (Average of two cultures; three plants in each culture.)

CULTURE NO.	DURATION OF EXPOSURE	HEIGHT OF PLANT	LENGTH OF ROOT	DRY WEIGHT		NUMBER OF LEAVES	EXTERNAL APPEARANCE OF PLANTS
				Top	Root		
		cm.	*cm.*	*grams*	*grams*		
1	Direct sunlight 6:00 a.m.—6:00 p.m.	52.5	60.0	3.35	2.60	8	Plants healthy with broad dark green leaves.
2	Diffused light 6:00 a.m.—6:00 p.m.	53.4	48.8	2.53	1.29	8	Plants slender with long narrow and rather chlorotic leaves.
3	Morning light 6:00 a.m.—12:00 M.	63.6	40.4	2.85	1.56	7.5	Plants fairly healthy with light green leaves.
4	Afternoon light 12:00 M.—6:00 p.m.	46.9	33.8	1.48	0.41	7	Plants stunted in growth and with thin chlorotic leaves.

Alicbangon plant. These cultures, consisting of one set only were started from cuttings on November 27, 1929. Each culture was run in duplicate, only one plant in each culture. After fifteen days, the plants were given the following treatments:

1. Exposed to afternoon sunlight, 12:00 M. to 6:00 p. m.
2. Exposed to morning sunlight, 6:00 a. m. to 12:00 M.
3. Exposed to diffused light from 6:00 a. m. to 6:00 p. m.
4. Exposed to direct sunlight from 6:00 a. m. to 6:00 p. m.

On January 16, 1930, the cultures were photographed (see fig. 4), and afterwards harvested. The experimental data shown in table 4 are under the following criteria: (*a*) initial height of plants, (*b*) height of plants at harvest, (*c*) growth increment, (*d*) dry weight of plants, and (*e*) external appearance of plants at harvest.

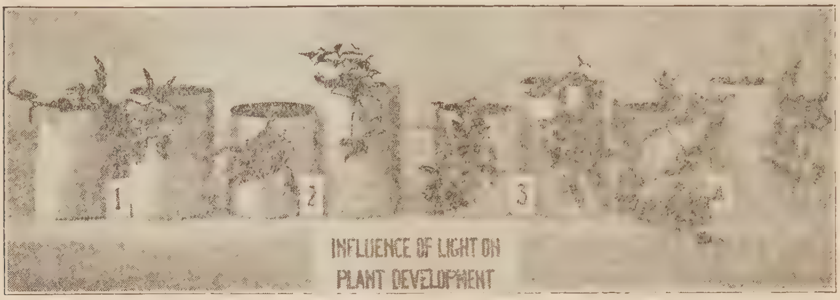

Fig. 4.—Alicbangon plants, started from cuttings and allowed to grow 15 days before treatment was begun:
(1) exposed to afternoon sunlight, 12:00 M. to 6:00 p. m.; (2) morning sunlight, 6:00 a. m. to 12:00 M.; (3) diffused light, 6:00 a. m. to 6:00 p. m., and (4) direct sunlight, 6:00 a. m. to 6:00 p. m.

TABLE 4

Growth and development of alicbangon, Commelina benghalensis (Commelinaceae) as influenced by light. (Average of duplicate cultures; one plant in each culture.)

CULTURE NO.	DURATION OF EXPOSURE	HEIGHT OF PLANT		GROWTH INCREMENT	DRY WEIGHT OF TOP	EXTERNAL APPEARANCE OF PLANTS
		Initial height	Height at harvest			
		cm.	*cm.*	*cm.*	*grams*	
1	Afternoon light 12 M.—6:00 p.m.	20.0	29.5	9.5	0.66	Plants stunted in growth; leaves fewer, thin and yellowish green.
2	Morning light 6:00 a.m.—12 M.	20.5	35.0	14.5	1.09	Stems slender, leaves fewer and pale green.
3	Diffused light 6:00 a.m.—6:00 p.m.	20.3	27.5	7.3	1.62	Stems slender, leaves silvery.
4	Direct sunlight 6:00 a.m.—6:00 p.m.	20.8	39.5	18.8	2.79	Stem and leaves deep violet in color, leaves rather thick.

Cucharitas plant. These plants were also started from cuttings with roots. Four duplicate cultures, one plant in each culture were started on November 27, 1929. The plants were first grown in the open for 20 days before they were given the following treatments:

1. Exposed to direct sunlight from 6:00 a. m. to 6:00 p. m.
2. Exposed to diffused light from 6:00 a. m. to 6:00 p. m.
3. Exposed to morning light, 6:00 a. m. to 12:00 M.
4. Exposed to afternoon sunlight, 12:00 M. to 6:00 p. m.

On February 19, 1930, the cultures were photographed (see fig. 5) and subsequently harvested. Data were gathered under the following criteria: (*a*) height of plant, (*b*) length of root, (*c*) dry weight of top, (*d*) dry weight of root, and (*e*) external appearance of plants at harvest and are presented in table 5.

TABLE 5

Growth and development of cucharitas (Alternanthera versicolor, Regel, Amaranthaceae), as influenced by light. (Average of duplicate cultures, one plant in each culture.)

CULTURE NO.	DURATION OF EXPOSURE	HEIGHT OF PLANT	LENGTH OF ROOT	DRY WEIGHT		EXTERNAL APPEARANCE OF PLANTS
				Top	Root	
		cm.	*cm.*	*grams*	*grams*	
1	Direct sunlight 6:00 a.m.—6:00 p.m.	20.1	10.4	7.20	0.64	Tops deep violet color, leaves rather thick.
2	Diffused light 6:00 a.m.—6:00 p.m.	19.5	14.1	5.27	0.51	Stems slender, leaves silvery in color.
3	Morning light 6:00 a.m.—12 M.	21.5	14.4	4.71	0.67	Stems thin and slender, leaves few and pale green.
4	Afternoon light 12:00 M.—6:00 p.m.	18.4	13.5	4.15	0.51	Leaves few but with thick surface and yellow-green in color. Stem brittle.

Pechay plants. One set of four duplicate cultures was started from seedlings on January 12, 1930. The cultures had only one plant each and were given the light exposure treatment as follows:

1. To direct sunlight from 6:00 a. m. to 6:00 p. m.
2. To diffused light from 6:00 a. m. to 6:00 p. m.
3. To morning sunlight, 6:00 a. m. to 12:00 M.
4. To afternoon sunlight, 12:00 M. to 6:00 p. m.

The cultures were photographed on February 25, 1930, (see fig. 6) and harvested on the following day. The experimental data are in table 6, gathered under the following criteria: (*a*) total number of leaves, (*b*) total area of leaves, (*c*) length of roots, (*d*) dry weight of top, (*e*) dry weight of roots, and (*f*) external appearance of the plants at harvest.

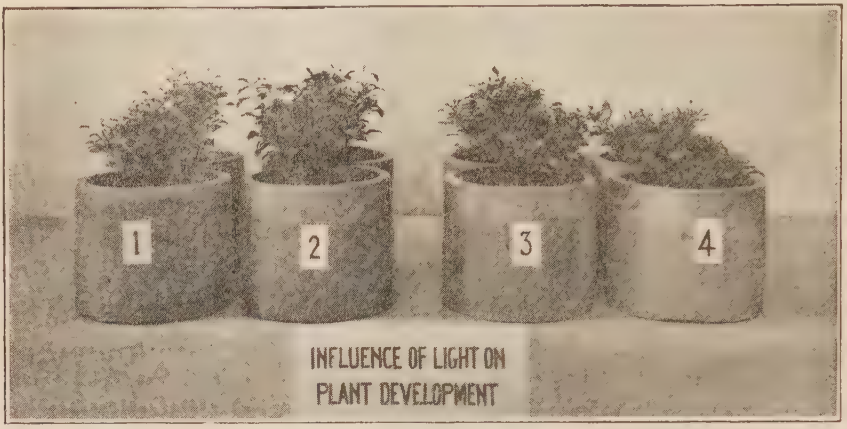

Fig. 5.—Cucharitas plants, 45 days old from cuttings with roots: (1) exposed to direct sunlight, 6:00 a. m. to 6:00 p. m .; (2) diffused light, 6:00 a. m. to 6:00 p. m.; (3) morning sunlight, 6:00 a. m. to 12:00 M., and (4) afternoon sunlight, 12:00 M. to 6:00 p. m.

TABLE 6

Growth and development of pechay, a form of Brassica juncea (L.) Cross. as influenced by light. (Average of the cultures; one plant in each culture.)

CULTURE NO.	DURATION OF EXPOSURE	TOTAL NUMBER OF LEAVES	TOTAL AREA OF LEAVES	LENGTH OF ROOTS	DRY WEIGHT		EXTERNAL APPEARANCE OF PLANTS
					Top	Root	
			sq. cm.	*cm.*	*grams*	*grams*	
1	Direct sunlight 6:00 a.m.—6:00 p.m.	17	3240	36.5	20.9	5.14	Plants healthy with thick broad dark green leaves.
2	Diffused light 6:00 a.m.—6:00 p.m.	8	463	17.3	1.05	0.15	Plants stunted in growth with few small thin light green leaves.
3	Morning light 6:00 a.m.—12:00 M.	12	1707	11.5	5.23	0.12	Plants rather healthy with broad green leaves.
4	Afternoon light 12:00 M.—6:00 a.m.	6	95	7.8	0.207	0.027	Plants stunted in growth with few small chlorotic leaves.

DISCUSSION OF RESULTS

Direct and diffused light and their effects on growth

By the data in tables 1-7 inclusive, it appears to be conclusively proved that the direct sunlight was far more effective in promoting plant growth and development than was the diffused light. This generalization holds good for all the five plants studied and under all the different criteria of results employed, except in one case, in which the number of leaves was the same in both of the cultures.

The first set of cultures of the rice plants which was photographed (see fig. 1) but not harvested, shows plainly that the rice plants grown directly exposed to the sunlight were far healthier, more vigorous, taller, and produced more dry matter than those that were supplied with only diffused sunlight.

Likewise, the rice plants in the second set of cultures, directly exposed to the sunlight (see fig. 2) were far more vigorous than those grown in diffused light. Data in table 1 bear out this observation under all the criteria employed. The ratio of the dry weight of the tops of the plants grown under direct sunlight to similar data obtained from the rice plants supplied with only diffused light was 2.3 to 1, (see table 7) in favor of the direct exposure.

TABLE 7

Ratios of dry weights of tops of plants that received different light intensity and duration

PLANTS USED	RATIO OF EFFECTS OF DIRECT SUNLIGHT TO THOSE OF DIFFUSED SUNLIGHT	RATIO OF EFFECTS OF MORNING SUNLIGHT TO THOSE OF AFTERNOON SUNLIGHT	REMARKS
1. Rice plant	2.3 : 1	3.1 : 1	Data taken from table 1
2. Maize plant	3.1 : 1	1.6 : 1	Data taken from table 2
3. Maize plant	1.3 : 1	2.6 : 1	Data taken from table 3
4. Alicbangon	1.7 : 1	1.5 : 1	Data taken from table 4
5. Cucharitas	1.3 : 1	1.1 : 1	Data taken from table 5
6. Pechay	19.9 : 1	25.2 : 1	Data taken from table 6

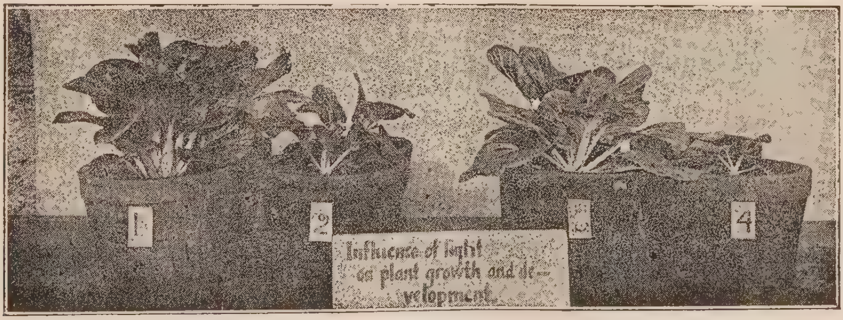

Fig. 6.—Pechay plants, 43 days old started from seedlings.
(1) exposed to direct sunlight, 6:00 a. m. to 6:00 p. m.; (2) diffused light, 6:00 a. m. to 6:00 p. m.; (3) morning sunlight, 6:00 a. m. to 12:00 M., and (4) afternoon sunlight, 12:00 M. to 6:00 p. m.

A similar order of results was obtained from the two sets of duplicate cultures of maize plants (see fig. 3 and tables 2 and 3); also from *Commelina*, or alicbangon (fig. 4 and table 4); from cucharitas (fig. 5 and table 5); and from the cultures of pechay, (see fig. 6 and table 6). As shown in table 7, the ratio of dry weights of tops of the plants grown directly exposed to the sunlight to those obtained from similar plants grown in diffused light was 3.1 to 1 for the maize plant in the first set of cultures and 1.3 to 1 for the second set. The ratio of *Commelina*, or alicbangon was 1.7 to 1; for cucharitas, 1.3 to 1; and 19.9 to 1 for pechay.

It appears sufficiently established, therefore, that of the five species of plants studied and with the slight discrepancy in dry weight of top obtained for the maize plants (ratios 3.1 to 1 and 1.3 to 1) the alicbangon and the cucharitas could thrive almost as well under the diffused light as under the direct sunlight. These two plants are, therefore, not very exacting with respect to light requirements. On the other hand, the other plant species, such as rice, maize, and pechay are decidedly exacting as to light requirements. These species were decidedly benefited by exposure to direct sunlight, (see fig. 1, 2, 3 and 6, and the data given in the corresponding tables). In other words, these plants are sun-loving plants,—not shade-loving plants.

Morning light and afternooon light and their influence on growth

The data in tables 1-7 as well as the illustrations in figures 1-6 conclusively show that under all the different criteria of results here employed the morning sunlight was more beneficial to all the five species of plants here studied than was the afternoon light. The length or duration of exposure to the light was the same, six hours, in each case, or treatment. The beneficial effects of the morning sunlight to the plants were so marked in some cases that the ratios of the dry weights of tops obtained from the contrasting exposures to the sunlight were wide. In the case of the rice plants the ratio was 3.1 to 1 in favor of the exposure to the morning sunlight. The ratio of the dry weights of tops of the pechay plants was still wider, being 25.2 to 1, also in favor of the morning exposure to the sunlight, (see table 7).

What causes this apparently more beneficial influence of the morning light, or rather the harmful effects of the afternoon light is now a pertinent question.

It was observed that light intensity was beneficial to all the five species of plants here studied. It is common knowledge that the temperature is higher in the afternoon than in the morning, might it not be that the higher temperature is the principal cause of the harm, although other causes may exist. Several investigators, as Copeland (1906) and others, have already established the fact that plants transpire more rapidly during the first hour or during the first two or three hours after the mid-day than at any other time of the day. Therefore, it appears that the harmful effects of the afternoon exposure were due to excessive transpiration. This, in turn, is facilitated or accelerated by the excessive heat usually experienced in the afternoon. Absence of water or the presence of moisture in pots could not be the cause, as the cultures were always sufficiently supplied with water.

Let us turn our attention to the harmful effects on plants of excessive transpiration. It is now common knowledge that when the loss of water by transpiration through the leaves is not soon replaced, the leaf cells lose turgescence. This loss of turgidity, in turn, closes the stomatal pores, and may produce a drooping, or flagging position of the leaves. Evidently, this was the case, as during the afternoon exposure, the plants appeared drowsy; the leaves drooped. Although not actually investigated at this time, from general knowledge on plant behavior, it could be suspected that the decrease of growth and development of the plants during the afternoon hours was due to the lack of turgor of the leaf cells; turgor is essential, at least, for the initial growth of the leaves. Moreover, the closing of the stomata and the drooping position of the leaves are two conditions well known as interfering with the photosynthetic activity of plants. It is, therefore, within reason to suspect that the manufacture of food slackens in the afternoon, which was probably the case in the present study, hence, the poorer growth.

TABLE 8

Data showing comparative effects of light intensity and light duration on growth

PLANTS USED	C NDITION OF LIGHT	DRY WEIGHT OF TOP	DRY WEIGHT OF ROOT	COMPILED FROM
Rice	Morning	2.67	0.53	Table 1
	Diffused	2.19	0.79	
Maize	Morning	3.33		Table 2
	Diffused	2.27		
Maize	Morning	3.85	1.56	Table 3
	Diffused	2.53	1.29	
Alicbangon	Morning	1.09		Table 4
	Diffused	1.62		
Cucharitas	Morning	4.71	0.67	Table 5
	Diffused	5.27	0.51	
Pechay	Morning	5.23	0.12	Table 6
	Diffused	1.05	0.15	

Light intensity vs. light duration in connection with growth

The data in table 8 (compiled from tables 1-6), seem to establish further the importance of the intensity of sunlight to plant growth and development,—particularly in the production of dry matter. With the exception of the two species, alicbangon and cucharitas (see table 8), each of the other species studied, rice, maize, and pechay, was able to produce a greater amount of dry matter when exposed to direct sunlight for a certain period in the morning than when exposed even twice that length of time in diffused light. Thus, for these three species of plants light intensity is most important. Of course, it should be recalled from previous discussion that even the cucharitas and the alicbangon did better in direct sunlight than in diffused light for equal duration.

Possible practical application of the results

It should be noted that all the five species of plants here studied are of some economic value. The rice and the maize are the most important. The pechay is also important, being a leaf crop; the alicbangon and the cucharitas are ornamental plants. Because of the value of the plants, the results of this study might be of value to farmers.

It is sufficiently established from the results of this study that the rice, maize, and the pechay are intense light-loving plants. As is the general practice of planters, these plants should be grown only in places and under conditions in which the maximum light intensity is available. Never should they be too closely planted, which would result in some of the plants or parts of plants being deprived of the much needed maximum illumination. For the same reason, these plants should never be planted where they would be shaded by large objects, such as buildings, trees or other plants.

The *Commelina*, (or alicbangon), and the cucharitas, not only produced the healthiest growth and development when directly exposed to the sunlight but they produced also a characteristic coloration of the leaves. The leaves had a deep violet color, (see tables 4 and 5). Should it be desired to produce this color of the leaves, then, the plants should be grown directly exposed to the sunshine. On the other hand, should green plants be desired, the alicbangon and the cucharitas should be grown in shady places, (also see tables 4 and 5), or in places where the plants could not receive the most intense sunlight. These two species were found rather tolerant to shade, or to the absence of intense illumination.

SUMMARY AND CONCLUSIONS

1. Direct sunlight was far more effective in promoting growth and development of the five species of plants here studied than was diffused light.

2. The alicbangon and the cucharitas could thrive almost as well under diffused light as under direct sunlight.

3. The rice, the maize, and the pechay were decidedly benefited by exposure to the direct sunlight. Diffused light was absolutely harmful to them.

4. The morning sunlight proved decidedly more beneficial to the plants here studied than the afternoon sunlight.

5. The rice, maize, and pechay each produced a greater amount of dry matter when exposed to direct sunlight in the morning than when exposed even twice that length of time to diffused light.

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NOTES ON SOME ECONOMIC PLANT DISEASES NEW IN THE PHILIPPINE ISLANDS: II[1]

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Of the Department of Plant Pathology

WITH THREE TEXT FIGURES

In 1924 the writer published a short note reporting a few diseases of economic plants which were new in the Philippine Islands. About a year later a report was made that the white rust of crucifers due to *Albugo candida* (Pers.) Russel., and its associated downy mildew fungus *Peronospora parasitica* (Pers.) Tul. occur in the Philippines, and that the Philippine fruit rot of eggplant is due to *Phytophthora melongenae* K. Sawada. In 1925 Drechsler of the United States Bureau of Plant Industry at Washington, D. C., working with herbarium specimens of corn collected from the Philippines supposedly containing *Helminthosporium inconspicuum* Ellis and Evht. called attention to the fact that the smaller spots on the leaves which had been confused with young lesions produced by the leaf-blight fungus *Helminthosporium inconspicuum*, are in reality due to another fungus, a new species, which he described as *Ophiobolus heterostrophus* Drechsler. This fungus has a conidial stage which Nisikado and Miyake of the Ōhara Institute for Plant Research in Japan, in 1926, described as *Helminthosporium maydis.* In 1926 and 1930 the writer reported the virus nature and transmissibility by *Pentalonia nigronervosa* Coq. of the bunchy-top of abacá, or Manila hemp (*Musa textilis* Née) which was previously attributed to eelworms and unfavorable environmental conditions. In 1927 Ocfemia and Roldan reported that the cause of the Philippine seedling and shoot blight of *Citrus* is a fungus identical with *Phytophthora faberi* Maubl. on coconut and cacao. In 1928 Ocfemia and Calinisan distinguished between abacá bunchy-top which is due to virus and root knot of abacá which is caused by *Heterodera radicicola* (Greef) Müller. In 1928 Palo reported the bulb rot of onion due to *Fusarium zonatum* (Sherb.) Wollenw. forma 1, and Clara of the Philippine Bureau of Plant Industry attributed the seedling blight of santol, *Sandoricum koetjape* (Burm. f.) Merr. to *Phytophthora phaseoli* Thaxter. In 1930 Leoncio found that *Fusarium cubense* EFS. causes wilt of abacá seedlings instead of heart rot, and Miss Mendiola ascribed the kernel blast of corn in the Philippines to *Fusarium moniliforme* Sheldon. Clara (1930) reports a bacterial leaf disease of tobacco caused by a new species of bacteria which he describes as *Phytomonas polycolor*.

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[1] Experiment Station contribution No. 701. Received for publication November 5, 1930.

The purpose of the present paper is to record the occurrence of diseases of economic plants and diseases of insects hitherto unreported from the Philippine Islands. The paper does not take into account the enormous number of new species of fungi and diseases of non-economic hosts.

1. ANANAS COMOSUS (L.) MERR. PINEAPPLE

A fasciation of pineapple seedling variety No. H 29 in the Plant Breeding Garden, Department of Agronomy, was collected by Mr. Simon Perez on January 17, 1929. The cause of the fasciation could not be attributed to any injury due to fungi, bacteria or insects. Examination of the specimen showed freedom from any organism or injuries due to various causes.

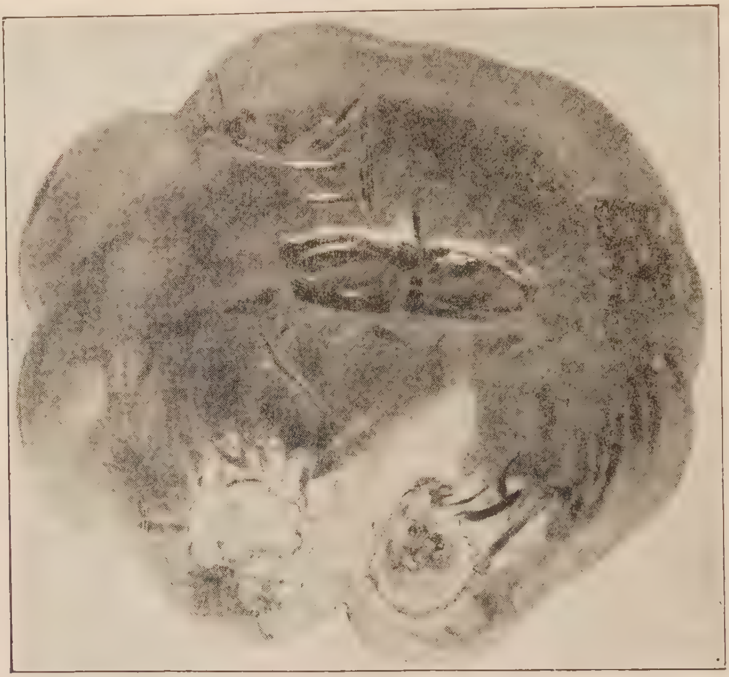

Fig. 1.—A ripe fruit of tomato, nearly natural size, showing two large lesions of the anthracnose disease. The lesions are covered with acervuli of a *Colletotrichum* tentatively considered identical with *C. phomoides* (Sacc.) Chester. (Photograph by the Photographic Division, Soils Department.)

2. CUCURBITA MAXIMA DUCH. SQUASH

A bacterial leaf spot hitherto unreported from the Philippines was collected in August, 1930. No work was done on the disease and the causal bacterium.

3. LYCOPERSICUM ESCULENTUM MILL. TOMATO

In gardens around Los Baños the rotting of about five per cent of the fruits of tomato has been shown to be due to anthracnose (fig. 1).

At first only a discoloration on the skin of fruits may be seen. The lesions are usually circular, distinct, sunken, soft and watery. Later on, bright and pinkish masses of conidia are produced on the dead areas. The masses of spores gradually become dark colored.

The anthracnose of tomato is due to a fungus very similar to *Collectotrichum phomoides* (Sacc.) Chester to which species the Philippine fungus is tentatively referred to by the writer. The acervuli of the fungus are subepidermal, dark-colored, setose ranging from 98.8 to 165 μ in diameter; the average is about 136 μ. The setae are dark-colored, septate, thick-walled, and 61-110 μ long.

The conidiophores are short, slender, arising from a well-developed stroma-like tissue, thin-walled, granular with few septa at the base, and 20.6-38.8 μ long; the average length is 26.7 μ.

The conidia vary in shape from almost straight to crescent-shaped, tapering at both ends, usually one-celled, granular, thin-walled, hyaline and 18.9-28.4×3.4-4.7 μ. When thinly sown in water the conidia germinate in from seven to ten hours. Upon germination, a conidium produces a germ tube which arises near one end. Each germinating conidium produces a septum near or at the middle perpendicular to its long axis. Chlamydospore-like bodies, or appresoria are produced at the tips of the germ tubes and these were noted after 16 to 24 hours.

In cross-inoculation experiments the fungus infected eggplant (*Solanum melongena* L.), camias (*Averrhoa bilimbi* L.), pepper (*Capsicum annuum* L.), and mango (*Mangifera indica* L.). Infection took place more readily if these plants were wounded than when they were not. The fungus is capable of attacking fruits of pepper which showed no visible injury.

4. MANGIFERA INDICA L. MANGO

A fasciation of mango twigs was collected in the College of Agriculture on May 16, 1929. The cause of the fasciation was not determined.

A bacterial leaf spot was collected by Mr. Severo Almazan on August 21, 1930. No work was done to determine whether or not this bacterial disease of the mango, hitherto unreported from the Philippines, is identical with the South African disease the cause of which was described by Miss Ethel M. Doidge as *Bacillus mangiferae.*

5. PSIDIUM GUAJAVA L. GUAVA

The anthracnose or canker of guava fruits is an old disease although the fungus associated with it has been only recently studied. The disease is common throughout the year although the blight of the shoots is more common during the wet season than during the dry weather. The most common form of the disease is the canker of the fruits (fig. 2). Angular spots of the older leaves also occur throughout the year. The disease is more serious on young water sprouts and on the fruits than on the older leaves. Approximately 50 per cent of the fruits may become hard, distorted, and unfit for use owing to infection by the canker. Guava is of importance locally because the ripe fruits are eaten raw, made into jelly or used in the preparation of various Filipino dishes. The plants are not usually cultivated although they may be found in back yards and near fences.

On the leaves the disease produces angular spots of varying sizes, usually two and rarely five millimeters in diameter and rusty brown in color. During the rainy season blight of shoots is the most common symptom. Blighted shoots are purplish in color turning dark-brown, dry and brittle.

The disease causes circular, dry, raised, and cankered spots on the fruits either scattered or in groups. As the spots grow the surface breaks open. On account of the rapid growth of the tissues bordering the spots the lesions finally become sunken. Infected fruits are undersized, irregularly shaped, hard, and not juicy. Infection of the fruits often follows injuries such as wounds made with the finger nails when pickers determine whether or not the fruits are ripe and soft.

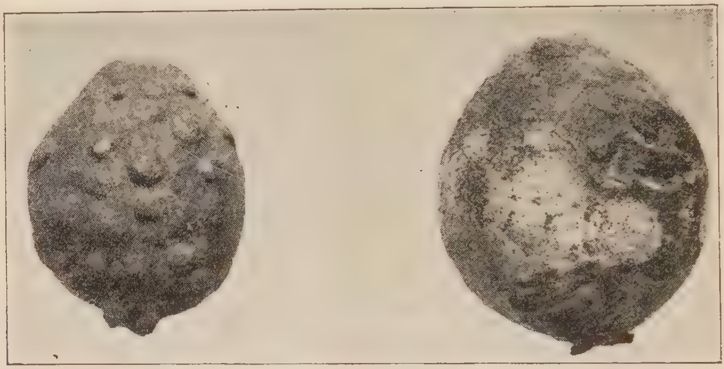

Fig. 2.—Dead and dry fruits of guava showing cankered areas due to a fungus provisionally considered as identical with *Glomerella psidii* (Del.) Sheldon. The fungus is also very similar to *G. cingulata* (Stonem.) S. and v. S. The larger fruit contains an abundance of perithecia. (Photograph by the Photographic Division, Soils Department.) Slightly reduced.

Guava-fruit canker is caused by a species of *Glomerella* probably identical with *Glomerella psidii* (Del.) Sheld. to which it is provisionally referred. The species is very similar to *Glomerella cingulata* (Stonem.) S. and v. S. reported by Shear and Wood (1913).

The acervuli are innate, erumpent, gregarious, ranging from rose-tinged to dark colored bodies. Occasionally a few short setae are present in the acervuli on the fruits. In culture the acervuli are more or less circular in shape, 84.5 to 574 μ in diameter; the average is 208.3 μ.

The conidiophores are filiform, thin-walled, granular. 20.4 μ long; the average length is 14.9 μ.

The conidia are hyaline, granular, continuous, obovate, rounded at the ends, 13.6-20.4×3.7-3.8 μ; the average size is 16.4×4.7 μ producing chlamydospore-like bodies or appresoria at the tips of the germ tubes on germination.

On dead infected fruits of guava, globular to pear-shaped, closely rostrate, membranous perithecia, which are 54.1-169.0×47.3-135.2 μ are produced. The average size of these perithecia is 106.8×88.3 μ.

The asci are clavate and are 50.7-84.5×11.4-15.6 μ; the average size is 57.6×13.8 μ.

The ascospores are ovoid to oblong, continuous, granular, more or less curved, tapering slightly at both ends, and 12.2-20.7×4.1-5.8 μ.

In artificial inoculation experiments using pure cultures the fungus on guava infects pepper (*Capsicum annuum* L.), eggplant (*Solanum melongena* L.), camias (*Averrhoa bilimbi* L.), tomato (*Lycopersicum esculentum* Mill.), avocado (*Persea americana* Mill.), banana (*Musa sapientum* L.), and mango (*Mangifera indica* L.).

6. ROSA SPP. ROSES

A species of *Cercospora* causes serious leaf spots of roses and often defoliates plants. In serious infection death of branches follows.

7. SACCHARUM OFFICINARUM L. SUGAR CANE

Since 1926 a Pythium-like fungus has been isolated from root rot of sugar cane.

An apparently new species of *Bacillus* causing stem rot of cane seedling varieties was collected by Mr. E. F. Roldan in September, 1929.

A species of *Fusarium* was associated by Mr. E. F. Roldan with a disease of P. O. J. 2878 canes, the symptoms of which are similar to those of Pokkah-boeng. Specimens of this disease were collected by Mr. Roldan in December, 1929.

The work of Mr. Roldan on the Pythium-like fungus, the bacterial stem rot of seedling cane varieties, and the *Fusarium* of Pokkah-boeng-like symptoms is in progress under the direction of Baker Memorial Professor F. L. Stevens.

Ergot of sugar cane caused by a species of *Claviceps* probably *Claviceps purpurea* (Fr.) Tul. was collected by Messrs. Simon Perez and Pedro Juachon on January 6, 1930, on arrows of seedling cane varieties C. A. C. 87 and P. B. 236 of the Plant Breeding Division, Department of Agronomy. With the occurrence of ergot on arrows of seedling cane varieties at Los Baños, Laguna, it seems that the causal fungus occurs on grasses in the Philippines.

8. VITIS VINIFERA L. GRAPE

Plasmopara viticola (B. and C.) Berl. and de Toni was collected by the writer in Los Baños, Laguna, on January 12, 1930. This is a temperate-zone fungus hitherto unreported from the Philippines.

Physopella vitis (Thum.) Arth. was collected by Dr. L. B. Uichanco in Calamba, Laguna, on March 10, 1925. This fungus occurs in the southern United States and in Mexico but is hitherto unrecorded from the Philippines.

9. ZEA MAYS L. CORN, MAIZE

A Pythium-like fungus was isolated by Mr. Roldan from rotting roots of corn. The work on this fungus is included with the Pythium root rot of sugar cane.

On September 13, 1929, Mr. Silverio M. Cendaña brought to the writer a leaf of corn with a disease similar in many respects to the Fiji disease of sugar cane.

The corn variety infected with the disease was the Yellow Flint. The kernels were planted on August 23 and 24 and the seedlings emerged on August 26 and 28. Previous to planting the corn, the field had been planted to mungo (*Phaseolus aureus* Roxb.) and the crop of this legume which was turned under was severely infected with leaf spot caused by *Cercospora cruenta* Sacc. Towards the north and lower end of the field were situated the Plant Pathology sugar cane experimental plots. In these plots mosaic, Fiji disease, leaf scald, and smut were present. Towards the northwest end the land was planted to sugar cane and this was followed with corn. In this field no galls could be found on the leaves of the corn although leaf spot due to *Ophiobolus heterostrophus* Drechsler and the Fusarium disease of kernels caused by *Fusarium moniliforme* Sheldon were present.

The leaf-gall disease of corn has never been reported from the Philippines. The percentage of infection in the field was about 90 per cent (fig. 3).

The young stage of the disease may be detected by the presence of somewhat shiny areas on the upper surface of the leaves. At first these shiny areas are in the form of streaks. The streaks coalesce both laterally and longitudinally forming larger areas sometimes occupying nearly the entire width of the leaf. The shiny areas do not extend quite to the tip and base of the leaves.

A little later the margins of the middle portion of the leaves begin to curl upwards. The curling begins where the shiny areas are widest. When the leaves are curled the shiny areas are conspicuous on the nether surface. There is a contrast between the healthy region and the diseased region because the former seems to be covered with bloom while the latter is somewhat shiny.

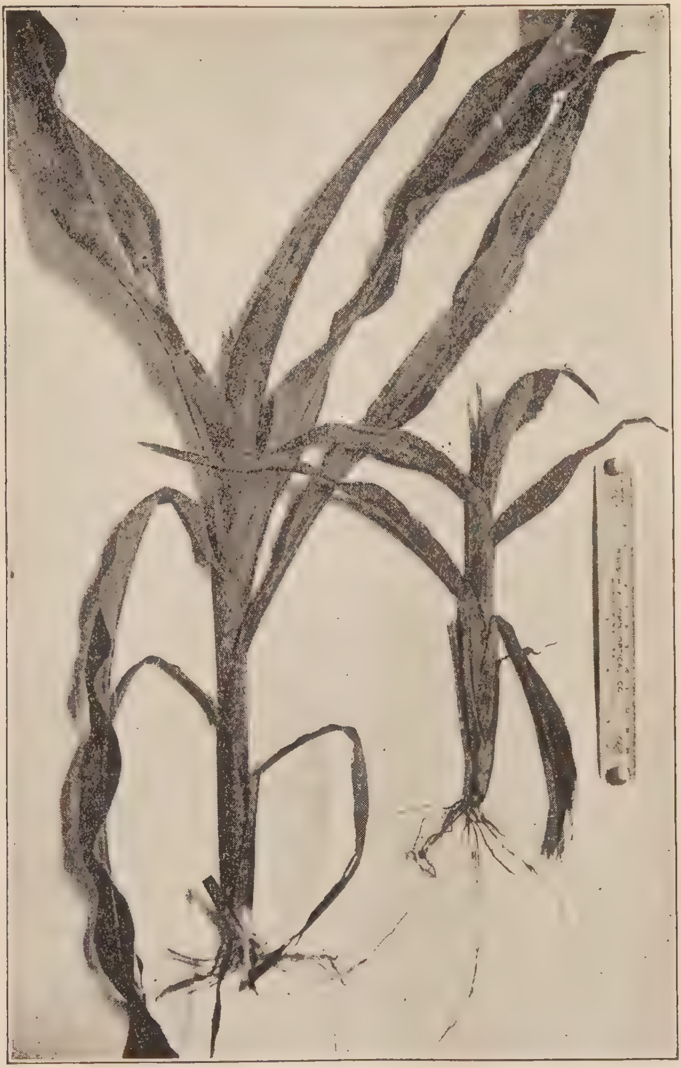

Fig. 3.—A healthy corn plant to the left and a diseased plant of the same variety and age to the right showing their relative size. Note the upper three expanded leaves of the plant to the right showing the long galls running parallel with each other and with the long axis of the leaf. The leaves are gradually becoming shorter and stiffer than those of the healthy plant. Note that the leaves begin to bend upwards in the form of short bows similar to those shown by sugar cane with Fiji disease. (Photograph by the Photographic Division, Soils Department.)

In the region of the shiny areas the veins become more transparent. Galls are formed on the main veins. At first the galls are small and elongate. They vary from one to three millimeters by one-third to one-half millimeter in size. By process of growth neighboring galls coalesce until sometimes they extend from the base to the tip of the leaves. The galls may extend to the leaf sheaths also. The site of the original galls may become knot-like in appearance.

There is a gradual shortening of the leaves of diseased plants. The leaves become stiffer and shorter than those of the healthy plants. They are curled along the margins and tend to bend upwards in the form of short bows. The most seriously infected plants are much stunted, the leaves are very short, and the youngest ones are pale green and almost aborted.

The nature and cause of this interesting new disease are not yet known.

10. FUNGOUS DISEASES OF IMPORTANT INSECTS

During the course of the writer's work on the transmission of bunchy-top of abacá with the aphid *Pentalonia nigronervosa* as vector it was noted that during the rainy season many of the aphids are killed by a fungous parasite. Specimens of the parasitized aphids were collected and sent to Dr. T. Petch, at Norfolk, England, for identification. In a letter to the writer dated April 17, 1930, Doctor Petch in part stated:

"The fungus on *Pentalonia nigronervosa* is a Cephalosporium, n. sp., which I propose to describe as *Cephalosporium crassum.*"

In January, 1929, Dr. L. B. Uichanco collected numerous dead white grubs (*ulalo*, Tagalog; *bucan*, Visayan) *Leucopholis irrorata* Chevrolat with fungous growths on them. The white grubs are of great importance to the Philippine sugar industry because they attack the underground parts of the sugar cane. The specimens of the dead white grubs were collected by Doctor Uichanco from Patay na Ilog, Cabuyao, Laguna. A specimen was sent to Doctor Petch on June 11, 1930, and the fungus was determined as *Cordyceps podocreoides* von Höhnel. In the letter containing the determination of the fungous parasite of the white grub, Doctor Petch states that "It resembles *Cordyceps gracilis* but has a rough head."

In addition to the specimens of *Leucopholis irrorata* a few adult coconut leaf miners, *Promecotheca cumingii* Baly infected with a fungous disease which were collected by Mr. Martin S. Celino were sent to Doctor Petch. According to Doctor Petch the fungous parasite of the *Promecotheca cumingii* is *Beauveria bassiana* (Bals.) Vuill.

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PRELIMINARY STUDIES ON THE POSSIBILITIES OF GREEN DUCK PRODUCTION[1]

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WITH ONE TEXT FIGURE AND ONE CHART

Duck meat is not looked upon with favor in the Philippines because most of the ducks sold in the markets are old, hence the meat is tough. Selling only the old ducks is an unwise practice of duck raisers. If they would feed their ducklings plenty of rich feed so that they would grow rapidly, an excellent meat is produced. Ducks thus raised and sent to the market while young are called "green" ducks. The meat of these ducks is tender and juicy and is a popular fowl meat in other countries.

Because "green" ducks are not produced in this country the principal product of the duck is eggs. As a consequence, one of the principal by-products of the mammoth duck egg hatcheries in Pateros and in other places where such hatcheries are operated is the male duckling. When the ducklings are about two or three days old, they are divided into two groups, male and female. At this age, the females are sold usually at about ₱30 a hundred to duck raisers who raise them for the production of eggs. With every one hundred females sold ten males are given free. Since there is on an average about the same number of male and female ducklings hatched each time, obviously there is a considerable number of male ducklings that are not used for breeding purposes. These excess male ducklings are sold at a very low price, usually at about ₱3 a hundred, either to be raised and sold when old for meat purposes or they are taken to the Manila markets and sold for about 10 centavos each.

The writers do not know of any study on the production of green ducks in this country. The present study was conducted to determine the possibilities of feeding male ducklings for the production of green ducks. The results obtained from this study should be of value to the different operators of the mammoth duck egg hatcheries as it shows a profitable way of disposing of the excess male ducklings. The study was carried on in the Department of Animal Husbandry, College of Agriculture, from January 4 to April 5, 1930, a period covering three months.

SEPARATING THE MALE FROM THE FEMALE DUCKLINGS[2]

To separate the male and female ducklings is not difficult, and can be done quickly, providing the one doing the work is fully acquainted with the

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[2] To the junior author belongs the credit of separating the female from the male ducklings used in this study.

technique. The method used in this study has been known by many Philippine duck raisers for many years. The legs of the duckling are held in one hand between the thumb and the forefinger, with the other three fingers on the back of the bird. The tail is held between the thumb and the forefinger of the other hand and the vent is slightly stretched. The middle finger presses the base of the tail at the same time that the cloaca is being forced to protrude; if the bird is male, a small knob-like projection of about half the size of a pin head comes out. No such projection will be seen if the bird is a female. (See fig. 1).

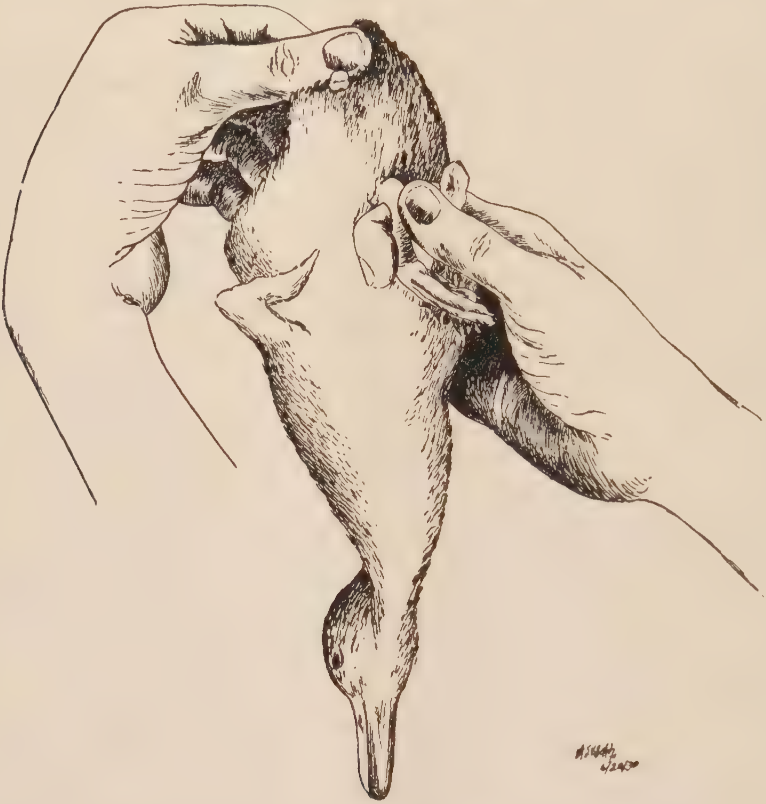

Fig. 1.—Manner of holding a duckling in separating male from female.

This method can be used easily with ducklings about three days old. When ducklings older than these are examined, the lower part of the intestines contain feces so that when the vent is stretched the feces is pressed out. This makes it rather difficult to examine the vent. At this age, before any examination is made, the feces should be wiped away, often several times.

MATERIALS AND METHODS

Although both male and female ducklings may be fed for the production of green ducks, in this study only male ducklings were used. During the first week 100 of these ducklings were given all that they would consume of cooked "rice of corn".[3] When one week old the ducklings were given wet mash consisting of 2 parts by weight each of corn meal and dried shrimps and 6 parts of rice bran. The ducklings were weighed at weekly intervals. In all cases, the weight was taken before the birds were given the first morning meal. Records of the amount of feed consumed as well as the mortality records were kept.

RESULTS AND DISCUSSION

Growth. The record of average weights of the ducklings used in this study is given in table 1, and is graphically shown in chart 1.

TABLE 1

Average weight and the increase in weight of male ducklings at different ages

DATE		AGE	NUMBER OF DUCKLINGS	AVERAGE WEIGHT	INCREASE IN WEIGHT
1930				*grams*	*grams*
Jan.	4	One day	100	37.7	———
	11	1 week	98	47.2	9.5
	18	2 weeks	96	67.3	20.1
	25	3 "	93	109.3	42.0
Feb.	1	4 "	90	243.0	133.7
	8	5 "	90	416.3	173.3
	15	6 "	90	606.1	189.8
	22	7 "	90	804.6	198.5
March	1	8 "	90	899.1	94.5
	8	9 "	88[a]	969.4	70.3
	15	10 "	84	1020.7	51.3
	22	11 "	79	1055.4	34.7
	29	12 "	55	1069.6	14.2
April	5	13 "	44	1082.4	12.8

[a] The sale of green ducks began on March 5, 1930.

By reference to this table, it can be seen that the ducklings grew very rapidly. It is very interesting to note that the average initial weight of 37.7 grams had almost doubled at the age of two weeks. The average weight at the age of three weeks was only about 4 grams less than three times the initial weight. Among Native chickens, Enerva (1926) observed that the cockerels and pullets doubled their initial weights by the fourth week. Dañgilan (1926) observed, however, that male Cantonese chicks had doubled their hatching weight when two weeks and the females when about four weeks old. From the third week of age, the ducklings grew at a much faster rate than either the male chicks of the Cantonese or of the Native fowls. At the end of the thirteenth week, the ducklings weighed over a kilogram each, while the male chicks averaged only about one half that much. These data reported by Enerva and Dañgilan represent normal rates of growth of male Native and Cantonese chickens.

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[3] "Rice of corn", is prepared by grinding corn to a very coarse meal; then the hard flinty material (horny endosperm) is cleaned and boiled in much the same manner as rice for human consumption.

It may be seen also from table 1 that the most rapid growth of the male ducklings was up to between one and eight weeks of age. After this period, the rate of increase gradually diminished and by the last week of the observation, the thirteenth week, the average increase was only 12.8 grams. These data are a good guide as to the proper time to market green ducks. Under the conditions in which this study was conducted, green ducks may be sold when about eight or nine weeks old, when the ducklings average a little less than a kilogram in weight. At the age of nine weeks, the ducklings weighed over twenty-five times the average initial weight.

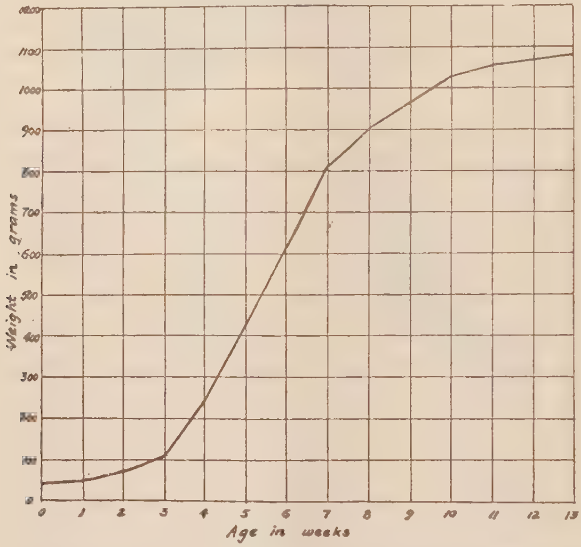

Chart 1.—Showing the rate of growth of male ducklings.

Feed consumption and cost. The total feed consumption and the cost of feeds are given in table 2. By reference to this table, it may be seen that the amount of feed consumed gradually increased as the ducklings grew older. Naturally, the cost increased in the same proportion. It may also be seen in table 2 that it cost only ₱0.35 to feed 100 male ducklings during the first week, and ₱0.73 to feed them during the second. During the fourth week, it cost ₱2.51 to feed 100 male ducklings and ₱4.75 to feed hem during the eighth week. At the time when the sale of green ducks was started between the eighth and the ninth weeks, it cost about ₱0.05 to feed each green duck a week. During the thirteenth week, the cost of feed increased to ₱0.06 each green duck. To feed 100 male ducklings from the first week to the end of the third month cost ₱46.08.

TABLE 2

Amount and cost of feed consumed by the ducklings at different ages

PERIOD	NUMBER OF BIRDS	FEED CONSUMED	COST OF FEED CONSUMED	COST OF FEED FOR EVERY 100 DUCKLINGS
weeks		*kgm.*	*pesos*	*pesos*
1	98	5.0[a]	0.34[b]	0.35
2	96	8.0	0.70[c]	0.73
3	93	12.0	1.04	1.12
4	90	26.0	2.26	2.51
5	90	36.0	3.13	3.48
6	90	40.0	3.48	3.86
7	90	45.0	3.92	4.35
8	90	49.0	4.26	4.74
9	88[d]	50.0	4.35	4.94
10	84	49.0	4.26	5.08
11	79	30.0	2.61	3.30
12	55	36.0	3.13	5.69
13	44	30.0	2.61	5.93
Total.....		416.0	36.09	46.08

[a] Rice of corn.
[b] At ₱0.068 a kgm.
[c] At ₱0.087 a kgm.
[d] Green ducks were sold when between eight and nine weeks old.

In the case of chickens, Paje (1927) reported that in feeds alone, the cost up to the end of the twelfth week was only ₱15.60. These 100 birds included both pullets and cockerels. Comparing this with the cost of feeds consumed by the ducklings, ₱40.15, it is safe to state that ducklings are much heavier feeders than chickens. This may be because during this period, the ducklings grew at a much more rapid rate than the chickens did. The difference in the cost of the feeds per kilogram of Paje's chickens and the ducklings used in this observation was not very much.

Market age of green ducks. The question that may be asked is: At what age should green ducks be sold in order to realize the maximum returns? The green ducks produced in this study were sold at the practically "give away" price of fifty centavos (₱0.50) a kilogram live weight.[4] The total value of the ducklings at different ages are given in table 3.

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[4] Table fowls were sold in this College at the time at eighty centavos (₱0.80) a kilogram live weight.

TABLE 3

Cost of the gains made by the ducklings compared with the cost of the feeds consumed at different ages, computed for every 100 birds

AGE	GAIN IN WEIGHT	VALUE	COST OF FEEDS	VALUE OF GAINS LESS COST OF FEEDS
weeks	*kgm.*	*pesos*	*pesos*	*pesos*
1	0.95	0.48	0.35	0.13
2	2.01	1.01	0.73	0.28
3	4.20	2.10	1.12	0.98
4	13.37	6.69	2.51	4.18
5	17.33	8.67	3.48	5.19
6	18.93	9.42	3.86	5.56
7	19.85	9.93	4.35	5.58
8	9.45	4.73	4.74	–0.01
9	7.03	3.52	4.94	–1.42
10	5.13	2.57	5.08	–2.51
11	3.47	1.74	3.30	–1.66
12	1.42	0.71	5.69	–4.98
13	1.28	0.64	5.93	–5.29

By reference to the last column of table 3 it may be seen that from the first week up to the end of the seventh week, the ducklings made profits over the cost of feeds consumed. These profits increased gradually as the ducklings became older, from ₱0.13 the first week to as high as ₱5.58 for every 100 birds the seventh week. Although the ducks continued to make gains in weight from the eighth week to the close of the experiment, these gains apparently were no longer profitable. The cost of feeds consumed to make the gains was more than the selling price of gains in weight made by the ducklings. Under these conditions, there was a loss of ₱0.01 the eighth week and the losses gradually increased up to ₱5.29 for every 100 green ducks the thirteenth week or at the end of the third month. From these figures, therefore, it may be stated that at ₱0.50 a kilogram green ducks should be sold when about seven or eight weeks old, but not later than the age of nine weeks. Beyond this period, the gains made by the green ducks are no longer profitable. If it were not that at the age of seven weeks the green ducks have not yet completed their change of feathers, thus making it very difficult to dress them, it would be most profitable to market them at the age of seven weeks. But at this age the individual birds are rather small, the average weight being only about 800 grams.

Mortality. The records of mortality show the following figures: first week, 2 died; second week, 2; third week, 3; fourth week, 3. After the fourth week, no death was recorded up to the close of the observations at the end of the third month. These figures represent a mortality of only

10 per cent, much lower than was expected. Enerva (1926) reported that the most critical period of the life of Native chicks is from the first to the fourth week; Dañgilan's report on Cantonese chicks was the same (1926). A mortality of about twenty per cent up to the age of three months is generally considered within the normal limits in case of chickens.

TABLE 4

Financial statement

Cost of 100 newly hatched ducklings	₱ 3.00
Cost of feeds consumed up to eight weeks old	19.13
Value of 90 eight-weeks-old green ducks, 78.22 kgm. at ₱0.50 a kgm.	39.11
Gross profit	16.98

Profit and loss. Would it be profitable to raise the excess male ducks in the mammoth hatcheries and sell them later at the age of eight weeks as green ducks, or would it be better to sell them as ducklings for about ₱3.00 for every 100 birds? The answer is: if the ducklings are sold immediately after hatching, the usual practice in Pateros, for ₱3.00 a hundred, there is a loss as the duck eggs hatched cost not less than ₱3.50 a hundred. Add to this the cost of hatching, and at once it may be seen that it is a losing proposition to sell the ducklings for ₱3.00 a hundred.

It may be seen from table 4 that if the ducklings are all sold at the age of eight weeks, they would bring, at the rate of ₱0.50 a kilogram live weight, a gross return of ₱39.11. The actual cost of feeds consumed by the ducklings up to this period amounted to ₱19.13; hence, a profit over the cost of feeds of ₱19.98 was realized. If the original cost of the ducklings at ₱3.00 a hundred, the price at which the excess male ducklings are sold at the hatcheries in Pateros, is included in the cost of the feeds consumed, a gross profit of ₱16.98 is still obtained from a working capital of only ₱22.13, and within the short period of only eight weeks. This represents a gross profit of about 77 per cent on the total working capital invested in the enterprise.

If it is desired that the ducklings weigh at least one kilogram before they are sold, the total weight of the ducks at that period, ten weeks old, would be 102.07 kilograms, computed for every 100 birds. This meat will be valued at ₱51.04, and the feed at ₱31.16. There would be a difference of only ₱19.98 over the cost of feeds. At the age of three months, the total weight of 100 green ducks would be about 108.24 kilograms, valued at ₱54.12. The total feed cost, however, would be ₱46.08, leaving only a margin of ₱8.04 to cover the cost of labor and other expenses. The income thus decreases gradually after the ducks reach the age of eight weeks.

A 10 per cent deduction for mortality should be allowed in the foregoing figures.

TABLE 5

Income that may be derived from 100 green ducks sold at different ages from 8 to 13 weeks when feeds cost _____ a kilogram and the ducks sell at ₱0.50 a kilogram live weight[a]

AGE / PRICE OF FEED	6 centavos	7 centavos	8 centavos	9 centavos	10 centavos	11 centavos	12 centavos	13 centavos	14 centavos
	pesos	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*
8 weeks....	31.70	29.49	27.28	25.07	22.86	20.65	18.44	16.23	14.02
9 weeks....	32.21	29.50	26.79	24.08	21.37	18.66	15.85	13.24	10.53
10 weeks....	31.84	28.64	25.44	22.24	19.04	15.84	12.64	9.44	6.24
11 weeks....	31.77	28.27	24.77	21.27	17.77	14.27	10.77	7.27	3.77
12 weeks....	30.32	26.46	22.60	18.74	14.88	11.02	8.16	3.30	–0.56
13 weeks....	29.16	25.00	20.84	16.68	12.52	8.36	4.20	0.04	–4.12

[a] Deduct the initial cost of the ducklings.

Table 5 was prepared to show the approximate income that may be derived from 100 green ducks sold at different ages from 8 to 13 weeks. The ducks, in this instance, were valued at ₱0.50 a kilogram live weight. From the figures given in this table, as well as from the figures in the proceeding table (table 6), a 10 per cent deduction should be allowed for mortality. It can be noted from this table that as the ducklings grew older, the income decreased. Naturally, the lower the cost of feeds, the greater the income. Fair returns can be expected from the sale of green ducks even as late as the thirteenth week provided that the feed cost does not exceed ₱0.10 a kilogram.

TABLE 6

Income that may be derived from 100 green ducks sold at different ages from 8 to 13 weeks when feeds cost ₱0.10 a kilogram and the ducks sell at _____ kilogram live weight[a]

AGE / PRICE OF DUCK	30 centavos	40 centavos	50 centavos	60 centavos	70 centavos	80 centavos	90 centavos	100 centavos
	pesos	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*
8 weeks............	4.87	13.86	22.86	31.84	40.84	49.83	58.82	67.81
9 weeks............	1.98	11.68	21.37	31.06	40.76	50.45	60.15	69.84
10 weeks............	–1.38	8.83	19.04	29.24	39.45	49.66	59.87	70.07
11 weeks............	–3.34	7.22	17.77	28.32	38.88	49.43	60.99	70.54
12 weeks............	–6.51	4.18	14.88	25.58	36.28	46.97	57.66	68.36
13 weeks............	–9.13	1.70	12.52	23.34	34.17	44.99	55.82	66.64

[a] Deduct the initial cost of the ducklings.

To provide a guide for fixing the market price of green ducks, table 6 was prepared. Considering that the feed costs ₱0.10 a kilogram it appears that ₱0.40 a kilogram live weight is the minimum rate at which the green ducks may be marketed to cover the cost of production. Even at this rate, the ducks should be disposed of when not older than eleven weeks. To provide a fair margin of profit, ₱0.50 a kilogram live weight appears to be a fair price. Obviously, the higher the price the green ducks may be sold for, the greater the profit.

Quality of the meat of green ducks. The Philippine consuming public generally discriminates against the meat of ducks offered in the markets on account of its rather objectionable fishy flavor as well as the tough texture. The flavor of the meat to a great extent is dependent upon the quality and kinds of feeds given the birds, and the texture upon the age. Not only are most of the mature ducks sold in the markets old but in addition to grain feed they have been fed with snails which give a fish-taste to the meat. As to the quality of the meat of the green ducks produced in this study the following statement received from a member of the faculty of the College of Agriculture who bought a number and served them at a dinner on March 29, 1930, is offered. The letter, under date of April 2, follows in part:

> Regarding the ten green ducks obtained from the Animal Husbandry Department which were cooked and served to our guests on March 29, 1930, I beg to inform you that so far I have not heard of any complaint relative to any peculiar taste of the meat of those birds. On the other hand, I received words of praise concerning them. In fact, a number of people mistook them for squabs, which is, indeed, highly complimentary for the taste and texture of the meat of those ducks.

Buyers of green ducks, however, have experienced some difficulty in dressing the birds. It is admitted that it is more difficult to dress green ducks than chickens. The reason for this is that the feathers of green ducks are softer and the skin is tenderer than that of the chicken. A good way to dress green ducks is to use steam, if this is not convenient the bird may be scalded. Care should be taken not to soak the duck in hot water too long otherwise the tender skin may be cooked and easily torn. The feathers should be removed not by pulling but by light rubbing. If there are pin feathers or young feathers to be removed, these may be picked out by the use of a blunt knife. This pinning process is rather tedious, but it is necessary in order to have a presentable carcass.

SUMMARY AND CONCLUSIONS

1. The results of a study on the possibilities of feeding excess male ducklings produced in the mammoth hatcheries in Pateros and in other places are reported in this paper.

2. It was observed that the most rapid growth of male ducklings was from the first to the seventh week. After this period, the rate of increase gradually diminished.

3. After the eighth week of age, the gains made by the ducklings were no longer profitable.

4. For maximum profits, green ducks may be sold when about seven or eight weeks old, but not later than nine weeks.

5. The study showed that there may be a fair profit in feeding to produce green ducks.

6. At fifty centavos (₱0.50) a kilogram live weight a gross profit of 77 per cent of the total working capital invested in feeding ducklings may be realized within the short period of eight weeks.

7. A very low mortality of 10 per cent was recorded up to the marketing age of the green ducks.

8. The meat of the green duck is of excellent quality.

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WATER-AND-OIL TREATMENT AGAINST SOIL-INHABITING TERMITES AND ANTS[1]

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Philippine termites of the genera *Coptotermes*, *Heterotermes*, *Termes*, and occasionally certain other forms, which build their nests under the ground, are injurious to posts and other wooden structures that are set in the soil or otherwise come in direct contact with it. There are also frequent cases of these ground-inhabiting termites laying their tunnels along cement walls of concrete buildings in order to reach the wooden floors and framework in the superstructure. The preventive measures recommended by various authors (Snyder, 1926, Light, 1929, and others); namely, that of using metal strips or shields on concrete bases to isolate the upper wooden parts of buildings from the ground probably constitute the best and most dependable method of protection against subterranean termites; but unfortunately the practice is not feasible for general adoption in the Philippines. It would be applicable only in the case of the more expensive permanent structures. In houses in the average *barrio* community, the primary consideration is cheapness, and the component parts are largely such short-lasting materials as bamboo, nipa, and rattan. Quite frequently, these buildings are very temporary affairs, and the owner cannot afford to set his posts on concrete foundations and put on extra appurtenances in the form of metal strips or shields. When the termites attack the posts or other parts of the building, as they invariably do, the damaged parts are replaced. More or less extensive repairs of this nature usually have to be made once a year or oftener.

Under such ideal conditions for termite attack wherein the stage is always set for infestation, damage may still be prevented or at least minimized by making regular and frequent inspection of the parts of the building in contact with the ground and promptly employing proper remedial measures. Ground-inhabiting termites betray their presence by the conspicuous tunnels of earth and other dark-colored materials that they construct to cover their exposed runways on objects above the surface of the soil.

Paris green has in recent years come into vogue in connection with the control both of subterranean and of wood-inhabiting termites in parts of the United States (Smith, 1930), Porto Rico (Van Zwaluwenburg, 1915, Wolcott, 1924), and elsewhere. Paris green is placed along the runways of termites so that in their march some of the poisonous dust will adhere to the insects' legs and bodies. The idea is to take advantage of the termites' habit of licking one another's body, whereby they thus eat some of the adhering particles of the poison. The result is that even the young nymphs and the queen in the nest would ultimately be poisoned by the workers when they return home. The writer has made but limited trials of this method of control; the results have been either fair or indifferent. Possibly by following the recommendation of Smith (1930) of scattering the dust in the termite runways with a De Vilbiss atomizer No. 79 better results could have been obtained. It is intended to follow this work up in our laboratory.

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[1] Experiment station contribution No. 703. Received for publication October 23, 1930.

During the past two years another method has been used by us in ridding the building which houses the Departments of Entomology and Plant Pathology of underground termites which from time to time build their tunnels up along the concrete walls to the wooden parts above. One of these species, which invaded the building in June, 1929, was *Coptotermes vastator* Light, a very destructive and not easily controlled pest. Repeated trials to locate the nest of that particular colony had failed; we had dug up the ground for a depth of one and one-half meters along the base of the wall where the tunnels had their connection, but without success. We had tried the Paris green method; we had fumigated the soil with a copious supply of calcium cyanide granules, but all to no avail. The other infestations were by species of *Termes*, two of which occurred on the wooden posts of the garage which were set in the ground and the rest in the building proper, as in *Coptotermes*.

The procedure we finally adopted was as follows: A shallow trench was dug in the soil where the termite tunnels were connected. This was then filled with water until the soil was so thoroughly drenched that absorption became very slow. If the place was near a faucet, a rubber hose was used; otherwise water was carried in pails. Enough waste engine oil (such as that drained from the crankcase of motor cars) or kerosene was then poured into the trench to make a very thick film on the surface of the water. As the water soaked downward, the oil was drawn by surface tension under the ground and through the communication galleries of the termites into the nest. Previous trials with oil alone, without water, had failed because the oil did not penetrate into the soil well enough to reach the main termite colonies and, beside the fact that more oil had to be used, the treatment resulted in merely shifting the direction of march of the ravagers.

In our trials with this method, both in the case of *Termes* and of the persistent *Coptotermes*, one treatment was found sufficient to destroy an entire colony. The day following the operation, tunnels were sometimes seen rebuilt on the walls, either partly or wholly, in their original location; but these were the work of the workers that had been caught in the upper parts of the building during the treatment and shut off from their nests by the oil. In some cases these tunnels continued to be rebuilt for two or three days, but after this period the last remaining representatives of the colony disappeared. Nests of *Termes* that were dug out a few days after treatment were found to contain only dead individuals. There has not been a single case or recurrence of infestation from the same source following each treatment.

The simplicity of the method, the ease in obtaining the materials used and at little or no cost, and its efficacy against subterranean termites are among its desirable features. The practice has been found to work with equal success on ground-inhabiting species of ants which are a frequent nuisance around houses and yards. When treating ants' nests, however, it was found unnecessary (and also decidedly inconvenient!) to dig a trench. The ground in which the openings of the nests were located was merely soaked thoroughly with water before oil was added. More water was then poured so as to give the oil better distribution. Several coconut-shellsful of water and a few tablespoonfuls of oil are all that are needed for treating an average ant's nest. Because of the injurious nature of mineral oils, the method should not, of course, be used if the nests are located at the bases of tree trunks or other valuable plants.

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JAVA SPIDER ORCHID (ARACHNIS FLOS-AËRIS REICHB. f.) IN THE PHILIPPINES[1]

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WITH TWO TEXT FIGURES

It is the showy colors of the flowers that attract and give beauty to many of the orchids found in florist's greenhouses. There are other orchids that are interesting rather than beautiful, the interest lying in the resem-

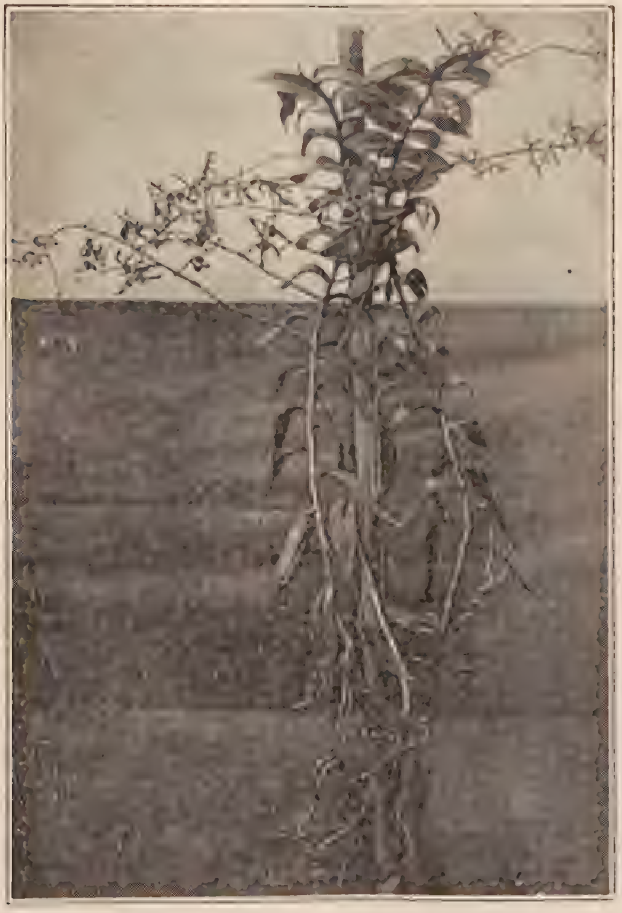

Fig. 1.—Cuttings of *Arachnis flos-aëris* Reichb. f. bearing clusters of flowers.

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[1] Experiment station contribution No. 701. Received for publication November 3, 1930.

blance of the flowers to familiar forms of animal life. Among Philippine orchids, for example, there is the *Calanthe furcata* Batem. ex Lindl. This is a ground orchid found on Mount Maquiling and in other regions in the Islands. This orchid produces flowers each of which looks like a miniature white bird in flight carrying a piece of ribbon in its beak. There is also a Philippine orchid, known botanically as *Cryptostylis arachnites* (Blm.) Hassk. which produces flowers that resemble spiders. The flowers of this orchid are comparatively small. A more striking example of orchids producing flowers like spiders is the Java spider orchid (*Arachnis flos-aëris* Reichb. f.). The blossoms of this orchid are fairly large. It is one of the most beautiful orchids of Java.

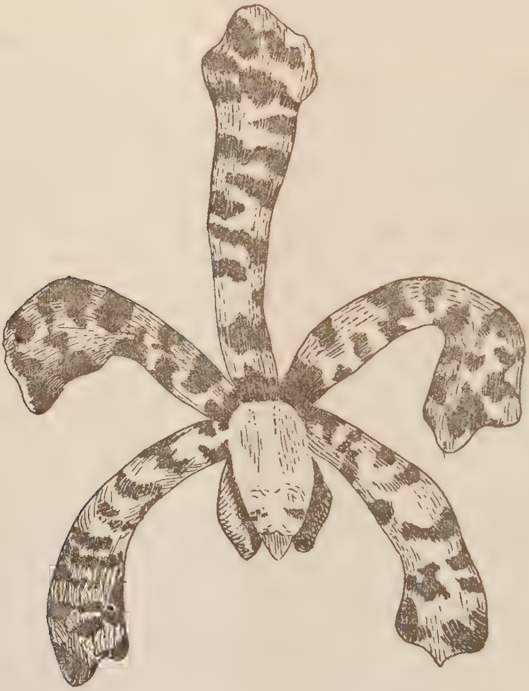

Fig. 2.—A life-size flower of *Arachnis flos-aëris* Reichb. f.

We have this interesting orchid in the Department of Agronomy of this College; we believe these are the only living specimens in the Philippines. At least, we feel quite sure that we possess the only specimen which has flowered in this country.

Arachnis flos-aëris, as figure 1 shows, is somewhat like the *Renantheras* in habit. For this reason, I had been calling this orchid a *Renanthera*, until I submitted a herbarium specimen of it to the Director of the Botanical Garden at Buitenzorg, Java, who gave me the correct name. It is quite likely that this is the same Java orchid that is called *Arachnanthe moschifera* Blume. in Williams' *The Orchid Growers Manual* (seventh edition) and given as synonymous with *Renanthera arachnites, Renanthera flos-aëris, Arachnis moschifera* and *Epidendrum flos-aëris.*

The flowers of *Arachnis flos-aëris* measure individually about nine centimeters in length and seven centimeters in width. They are lemon colored with spots of purple. (See figure 2.)

The plant specimens which are found in the orchid collection of this department came originally from cuttings which were brought to this College in 1923 with other plant immigrants by the late Dean Charles Fuller Baker of this institution. These cuttings were planted in the ground in a shady place. After about three years, the plants had not flowered although they had climbed to a height of about three meters on a trellis made of pieces of bamboo. In 1926 new cuttings were obtained from the old plants and planted in the same way as the old but in a more exposed place. In January of this year (1930), about four years later, and again in May, the plants produced flowers, after attaining a height of about four meters. The credit of taking care of this orchid for the last six or seven years belongs to Mr. Vicente Dawis of this College who is in charge of our floriculture work.

Cuttings of this spider orchid bearing spikes of flowers were exhibited on June 14 and 15, 1930, in the College of Agriculture booth at the exhibition grounds of the School of Forestry, Los Baños, on the occasion of the twentieth anniversary of this institution.

PH AND ACIDITY DETERMINATIONS OF CANE JUICES EXPRESSED BY A FOURTEEN ROLLER MILLING PLANT[1]

FRANCISCO S. GOMEZ

WITH SEVEN GRAPHS

INTRODUCTION

Cane juice can roughly be described as a complex aqueous solution containing sugars, acids, and salts. This solution therefore contains both hydrogen ions and hydroxyl ions. The raw juice contains an excess of hydrogen ions or, in general, the cane juice is acidic in nature. A study of cane juice acidity in the different mills in a milling plant is of great importance, as an increase in acidity of the cane juice in the different mills may result in a loss of sucrose by inversion. If such an increase in acidity could be prevented, there would be a large recovery of sucrose from the cane juice.

The possible inversion of sucrose in a milling plant may be the result of bacterial action upon the sucrose in the juice or it may be due to the increased production of acids through bacterial growth and through the acidity normally present.

The inversion of sucrose with the production of reducing sugars is a direct action of either acids or invertase. The destruction of sucrose by bacteria generally results in the formation of alcohol or acetic acid and butyric acid. The prevention of sucrose destruction during the milling of the cane must, therefore, be dependent upon the knowledge of the possible acidity, the total $H^{\pm}$ present, and the pH or the potential acidity.

The problem of determining the average acidity and pH by potentiometric method was undertaken in this investigation in order to estimate the normal acidity of cane juice so as to arrive at a reasonable interpretation of the possible $H^{\pm}$ increase in each juice expressed by the various mills. If a considerable decrease in pH or an increase in acidity from the crusher juice to the last mill juice is found, it would be reasonable to expect that this increase in acidity was due to the formation of acids from the sucrose by microörganisms or by chemical action and mill pressure.

The problem of determining pH and acidity of cane juices in a milling plant is most important to mill engineers and central managers as a one per cent destruction of sucrose during the juice extraction in a milling season may result in a ₱30,000 loss to a central milling 200,000 tons of cane.

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[1] Thesis presented for graduation, 1931, with the degree of Bachelor of Science in Sugar Technology from the College of Agriculture No. 325; Experiment Station contribution No. 705. Prepared in the Department of Agricultural Chemistry under the direction of Professor Reginald H. King.

Review of literature

McCleery (1924) working on the deterioration of cane mill juices, from the aspect of acidity increase, found that during milling operations there is a considerable loss of sucrose from deterioration caused by bacterial action. The development of bacteria around the mills results in acid products. McCleery used the increase in acidity as an index of the amount of bacterial development. In 1923, he found that the acidity of mill juices in the latter part of the train was as high or even higher than in the crusher juice.

Several tests were conducted in 1923 by E. D. Roberts (cited by McCleery, 1924) on the milling plant of the Hawaiian Sugar Company, in an effort to find the cause of the high acidity in the mixed juice. Cane stalks were examined and the juice as expressed by the laboratory mill was so much lower in acidity than that of the mixed juice, that it was evident that the acidity must be increasing in the milling plant. Composite samples were taken from each mill, from the pans below the mills, the juice troughs, and the supply pipes, and upon computation of the results, it was found that the increases in acidity and the subsequent losses due to this action were much larger than had been the prevailing opinion. It was stated that the increase in acidity from the first to the last mill was especially marked towards the end of the week. The only thorough cleaning given the mills was on Sunday mornings. Hence, it was concluded that these tests indicated that the deterioration was mainly due to an increasing insanitary condition as the week advanced. It was expected that the relation of acidity in the first mill and mixed juice would be in direct proportion to the dilution applied, but the acidity per 100 cc. was in many cases as high or even higher in the third and fourth mill juices than in the crusher juice. In the course of time, a system was started of cleaning and flushing with hot water and liming all spaces through which the juice passed, sometimes three and four times a day; the immediate result was that the percentage of acidity decreased and the clarification improved. These data are given in tables 14 and 15.

E. D. Roberts (cited by McCleery, 1924) concluded that a depression in mixed juice purity of 1.0° through deterioration, which is not unreasonable according to other tests, corresponds to about 1.2 per cent sucrose loss. This in turn amounts to approximately an additional 1.0 per cent loss inthe boiling house or a total loss of 2.3 per cent. Considering this loss it is evident that any saving of undetermined loss around the milling plants by preventing deterioration is well worth any effort expended.

Geerligs (1924) reported that the purity of the last mill juice is found to be much lower than corresponds with the natural decrease in purities from the first to the last mills. This fact is ascribed to souring during the course of the juice used for maceration. If such be the case, it might be that loss of sucrose by inversion is heavier than the financial advantage arising from the saving of fuel by the maceration with mill juice instead of water. This drop in purity was due to the fact that the mills had not been washed for a whole week. From his figures, the acidity increases from the first to the last mills.

Spencer (1929) found that the freshly extracted cane juices were immediately infected with a very large number of microörganisms, many of which are capable of rapidly inverting sucrose. He suggested that it is very essential to keep the mills as free as possible from deteriorated material, such as fermented portions of bagasse or particles of trash which had absorbed fermented juice.

Paine and Balch (1928) who worked on the further applications of the dye test to raw sugar manufacture and to refining of raw sugar with vegetable carbon found that there is an increase in pH of the juice from the crusher to the last mill. The increase of pH of the juice in the last mill is due to the slightly alkaline reaction of the maceration water. Also the Petrie process of returning mud to the bagasse blanket between the second and third mill increased the pH, owing to the return of the alkaline mud.

Object of the present work

The object of the present work was to study the pH and acidity of cane juices as the cane passes from the crusher through the different mills in order to determine the acidity and pH change, and also to evaluate the possible loss of sucrose during the milling of sugar cane.

Time and place of the present work

The work was done in the Sugar Laboratory of the Pampanga Sugar Development Company in Luzon and in the U. P. Sugar Mill at the College of Agriculture, from October, 1929 to March, 1930.

MATERIALS AND APPARATUS

Chemical reagents used

The chemical reagents used in this work were: .1056 N sodium hydroxide, .1055 N hydrochloric acid, phenolphthalein, quinhydrone, Horne's C. P. dry lead subacetate, methylene blue solution, neutral lead acetate, Soxhlet's solution and copper sulfate solution.

Apparatus used

Leeds and Northrup's potentiometer, burettes, pipettes, Brix spindles (HSPA certificate), polariscope, and accessories, beakers calibrated at 27.5° C., Erlenmeyer flasks, and graduated glass cylinders were used.

Preparation of samples

Samples of cane juice were taken from the different mills. Six copper buckets were used for this purpose. Sampling was done in such a way that the juice taken from the different mills came from the same cane stalks. In the writer's observation it takes with average mill speed at least five minutes for cane to pass from the crusher to the last mill. A majority of the canes milled were Luzon White and Pampanga Red. No preservative was used.

In the U. P. Sugar Mill, the juice was taken from the crusher only. Crusher juice was used in determining the possible loss of sucrose by bacterial decomposition with time.

General cleaning was done only on Monday, that is, once a week. The mill was washed with water and a spray of lime solution was forced through the juice troughs and mills. Maceration water was applied in the mills. This water was composed of artesian well water and condensate from the first effect evaporator. The mill housing, pit, and rollers were kept clean. Bagasse accumulations were always removed from the juice troughs.

METHODS

pH determination

The potentiometric method was used in determining the pH of the juice. Samples of juice from the different mills were placed in 50 cc. beakers. About $^1/_{10}$ gram of quinhydrone was added to each of the beakers of juice and thoroughly stirred. The electrodes were dipped into the solution and the potentiometer was manipulated until the pointer recorded zero at the galvanometer. The reading was recorded.

Dawson's formula for obtaining the pH from the quinhydrone electrode voltage is:

$pH = \frac{.4538 - R,}{0.06}$ where *R* stands for the E. M. F.

The pH was used to calculate the H ion concentration in the following manner:
If the pH of juice is 5.38 then by the formula:

$$pH = \log \frac{1}{H\pm}$$

$$5.38 = \log \frac{1}{H\pm}$$

$$5.38 = \log \frac{1}{H\pm} \times \frac{10^6}{10^6}$$

$$5.38 = 6 - \log H\pm \times 10^6$$

$$\log H\pm \times 10^6 = 6 - 5.38$$

$$\log H\pm \times 10^6 = .62$$

$$\log H\pm = \frac{.62}{10^6}$$

$$\text{antilog } .62\ H\pm = \frac{4.169}{10^6}$$

$$= .000004\ \ 169$$

$$= 4.169 \times 10^{-6} \text{ grams per 1000 cc. of juice.}$$

Therefore a pH of 5.38 is equivalent to 4.169×10^{-6} grams H ± per 1000 cc. juice.

Brix determination

Samples of juice taken from the different mills were placed in the glass cylinders and allowed to stand until the entrained air had risen to the top. This air or scum was displaced by additional juice. The Brix solids were determined by slowly immersing a clean, dry Brix spindle, wetting the stem for about an eighth of an inch above the highest point touched by the meniscus. The reading was noted, and the spindle was again depressed for a short distance above the top of the meniscus and the reading again taken. This was repeated until a constant reading was obtained.

Acidity determination

Exactly five cc. of juice from each sample of the juices frōm the different mills was taken in a 250-Erlenmeyer flask. One hundred cc. of distilled water was added to the flask. The solution was titrated with .1056 N sodium hydroxide, using phenolphthalein as indicator, until the solution showed a constant color. A constant color reaction was used as the end point of the titration which corresponded to pH 8.3. Duplicate determinations were made on each sample.

The acidity in terms of cc. of NaoH was converted to H ion concentration in the following manner:

Assume the Brix of the crusher juice to be 17.6 and .85 cc. of the NaoH was used to bring the sample to pH 8.3 then,

$.0001056 \times .85 = .00008976$ gram H ± per 5 cc. juice
$.00008976 \times 20 = .001795$ grams H ± per 100 cc. juice
or 01795 gram H ± per 1000 cc. juice

Method to get grams H ± per 100 Brix solids:

From the Brix 17.6 the corresponding specific gravity of the juice which is 1.072 can be found.

$1.072 \times 100 = 107.2$ wt. of 100 cc. juice
$107.2 \times 17.6 = 1886.72$ Brix solids

$$\frac{.01795 \times 100}{1886.72} = .00095 \text{ or } .95 \times 10^{-3} \text{ grams H} \pm \text{ per 100 Brix solids.}$$

Glucose was determined by the methylene blue method as described by McAllep (1926).

Method of calculating juice extraction of each mill

Juice extraction consists of primary and secondary extractions. The primary extraction includes the crusher and first mill juices and that expressed without maceration, while the secondary extraction includes the second mill to the last mill juices obtained by the application of maceration water.

The following will illustrate the method of calculating the primary and secondary extractions:

W = maceration % cane = 15.27

M = fiber % in bagasse

Crusher = 30.57 fiber % in bagasse

First mill = 35.26 fiber % in bagasse

Second mill = 43.02 fiber % in bagasse

Third mill = 44.55 fiber % in bagasse

Last mill = 46.08 fiber % in bagasse

F = Fiber in cane = 11.00

N = Number of times of application of water in mills = 3

Noel Deerr's formula for primary extraction:

$$Pe = \frac{m-f}{m(l-f)}$$

By substitution,

$$Pe = \frac{46.08-11}{46.08\ (1-11)} = 85.54$$

$$r = \frac{wm}{wm \pm f\ (l-m)}$$

By substitution,

$$r = \frac{15.27 \times 46.08}{15.27 \times 46.08 \pm 11\ (100-46.08)} = .5426$$

Secondary extraction:

$$Se = \frac{(l-\ m-f)}{m-f} \times \frac{(r\ |\ (l-r)^n\ -r^n)\ ]}{(l-r)\ \pm l-r^n \pm l}$$

By substitution,

$$Se = \frac{(1\ -\ 46.08-11)}{46.08(1-11)} \quad \frac{(.5426\ (1-.5426)^3}{(1\ -\ .5426)^4\ -\ .5426^4)}$$

$$\underline{-\ .5426^3)}\ =\ 11.71$$

Total extraction is the sum of primary and secondary extraction which is equal to 97.25 of the juice present in the cane. The method of calculating extraction by each mill using fiber determinations is as follows:

One hundred minus the bagasse per cent cane of each mill will give the corresponding juice extraction per cent cane.

Example:

Crusher $100-\frac{11.00}{30.57}=64.02$ juice extraction % cane.

$\frac{64.02\times 100}{100-11}=71.93$ juice extraction % juice in cane.

First mill $100-\frac{11.00}{35.26}-64.02=4.79$ juice extraction cane.

$\frac{4.79\times 100}{100-11}=5.38$ juice extraction % juice in cane.

Second mill $100-\frac{11.00}{42.02}-64.02-4.79=5.63$ juice extraction % cane.

$\frac{5.63\times 100}{100-11}=6.33$ juice extraction % juice in cane.

Third mill $100-\frac{11.00}{44.55}-64.02-4.79-5.63=.87$ juice extraction % cane.

$\frac{.87\times 100}{100-11}=.97$ juice extraction % juice in cane.

Fourth mill $100-\frac{11.00}{46.87}-64.02-4.79-5.63-.87=1.82$ juice extraction % cane.

$\frac{1.82\times 100}{100-11}-2.05$ juice extraction % juice in cane.

Method of calculating grams hydrogen ion concentration in different mill units per 100 tons of cane

Illustration

Mill units	*Per cent juice extraction*	*Grams H ± by titration per liter*	*Specific gravity*
Crusher	71.93	.01508	1.0707
First mill	5.38	.01746	1.0681
Second mill	6.33	.01712	1.05401
Third mill	.97	.01543	1.04149
Fourth mill	2.05	.01067	1.0224
Mixed juice		.01575	1.0625

Fiber in cane = 10.80
Maceration % cane = 15.27
Total juice extraction = 97.25

Crusher:
(100 − 10.8) (.7193) = 64.16156 tons juice.
$\frac{64.16156}{1.0707}$ – 59,924.87 liters juice.
59,924.8 × .01508 grams H ± = 903.67 grams H ± in crusher.

First mill:
(100 − 10.8) × .0538 = 4.79896 tons juice.
$\frac{4.79896}{1.0681}$ = 4,492.99 liters juice.
4,492.99 × .01746 grams H ± = 78.45 grams H ± first mill juice.

Second mill:
(100 − 10.8) × .0633 = 5.64636 tons juice.
$\frac{5.64636}{1.05401}$ = 5,357.03 liters juice.
5,357.03 × .01712 grams H ± = 91.71 grams H ± in second mill juice.

Third mill:
(100 − 10.8) × .0097 = .86524 tons juice.
$\frac{.86524}{1.04149}$ – 830.771 liters juice.
830.771 × .01543 grams H ± – 12.82 grams H ± in third mill juice.

Fourth mill:
(100 − 10.8) × .0205 = 1.8286 tons juice.
$\frac{1.8286}{1.0224}$ = 1,788.54 liters juice.
1,788.54 × .01067 grams H ± = 19.08 grams H ± in fourth mill juice.

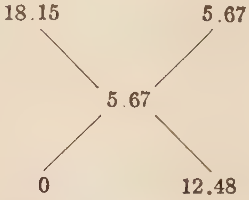
Mixed juice:
(100 − 10.8) × .9725 = 86.747 total extraction.
15.27 maceration % cane.
102.017 tons juice in mixed juice.
$\frac{102.017}{1.0625}$ = 96016.00 liters juice.
96016.00 × .01575 grams H ± = 1440.24 grams H ± in mixed juice.

Method of calculating grams hydrogen ion concentration in different mills discarding return juices

Illustration

Brix of normal juice = 18.15

Brix of fourth mill juice = 5.67



This diagram shows that there are 5.67 parts of juice and 12.48 parts of maceration water in the last mill juice.

The volume of normal juice extracted by the fourth mill based on 100 tons cane ground is 1,788.55 liters.

$$\frac{1,788.55}{X} = \frac{5.67}{12.48}$$

X = 3,936.70 liters of maceration water to be added to normal juice extracted by the fourth mill.

Fourth mill:

1,788.54 liters normal juice.

3,936.70 maceration water.

5,725.24 liters diluted normal juice actually passing through the fourth mill and then going to the third mill.

5,727.24 × .01067 gram hydrogen ion.

= 61.09 grams hydrogen ion in the fourth mill when the juice is diluted.

1,788.54 × .01746 gram hydrogen ion.

= 31.23 grams hydrogen ion (theoretical).

Third mill:

5,725.24 diluted juice.

803.77 liters normal juice due third mill.

6,529.01 liters diluted normal juice actually passing through the third mill and then going to the second mill.

5,529.01 × .01543 gram hydrogen ion.

= 100.74 grams hydrogen ion in the fourth mill when juice is diluted.

803.77 × .01746 = 14.03 grams hydrogen ion (theoretical).

Second mill:

6,529.01 diluted juice.

5,357.03 liters normal juice due second mill.

11,886.04 liters diluted juice coming from the second mill base in 100 tons cane ground.

11,886.04 × .01712 gram hydrogen ion.

= 203.49 grams hydrogen ion in the second mill.

5,357.03 × .01746 = 93.53 grams hydrogen ion (theoretical).

First mill and crusher determinations, the same as in methods of calculating grams hydrogen ion concentration in different mill units per 100 tons of cane.

Units	Theoretical grams hydrogen ion	Actual grams hydrogen ion
Crusher	903.67	903.67
First mill	78.45	78.45
Second mill	93.53	203.45
Third mill	14.03	100.74
Fourth mill	31.23	61.09
Sum	1120.91	1347.40

The mixed juice contains 1440.24 grams hydrogen ion. The 203.45 grams hydrogen ion in second mill includes the sum of the hydrogen ion in the third and fourth mills. Subtracting the sum of the grams hydrogen ions of the third and fourth mills from 203.45 grams hydrogen ion, gives the grams hydrogen ion present in the second mill.

MILL DATA

Purities of juice

Apparent purity is the ratio of the per cent polarization and the corrected Brix times one hundred.

Tons cane per hour

Tons cane per hour is the ratio of the total tons cane ground for the day and total number of hours grinding for the day.

Maceration per cent cane

Maceration per cent cane is equal to bagasse percentage cane plus mixed juice per cent cane minus one hundred.

Extraction per cent cane

Extraction per cent cane is equal to polarization per cent cane minus polarization in bagasse per cent cane.

Fiber in cane

Fiber in cane is the ratio of the constant weight of dried fiber and the weight of cane taken for analysis.

Fiber in bagasse

Fiber in bagasse is the ratio of the constant weight of dried fiber and the weight of bagasse taken.

EXPLANATION OF TABLES[2]

Table 1 is the summary of results and shows the summarized data of acidity increase, pH, grams H ± concentration per 100 Brix solids, Brix for various units of the milling plant, juice purities, and other mill data.

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[2] Tables 4 to 15 are on file in Division of Sugar Technology, Department of Chemistry, College of Agriculture.

Table 2 shows the characteristics of cane juice held without heat or lime treatment.

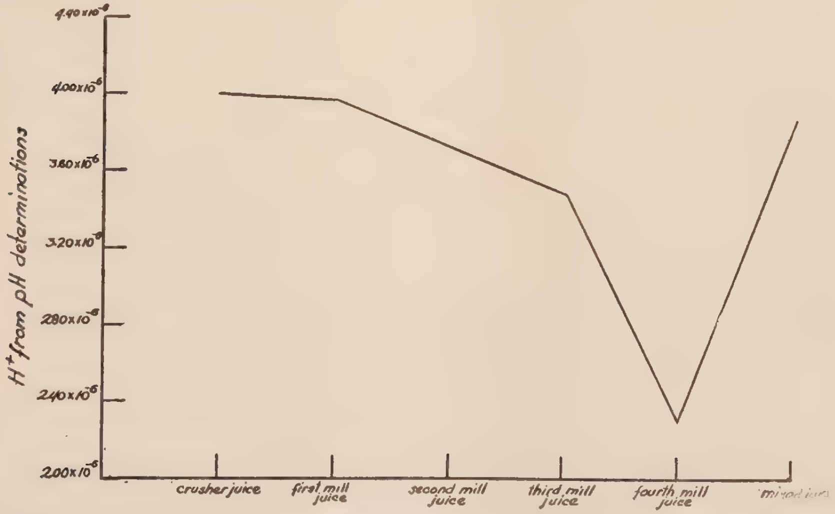
Table 3 shows the increase in acidity in cane juice with time.

Tables 4 to 9 shows the hydrogen ion concentration by titration, from pH determinations, Brix solids, and grams H ± concentration per 100 Brix solids for various units of the milling plant.

Table 10 shows the average of the hydrogen ion concentration by titration by pH determinations and grams H ± concentration per 100 Brix solids by days for various units of the milling plant.

Table 11 shows the increase in acidity from titration, pH determinations, and acidity per 100 Brix solids from the crusher juice to mixed juice using crusher juice as base.

Table 12 shows the increase in acidity from titration, pH determinations, and acidity per 100 Brix solids from Tuesday to Sunday using Tuesday as base.



Graph 1.—Relationship between average hydrogen ion concentration from titration and mill unit.

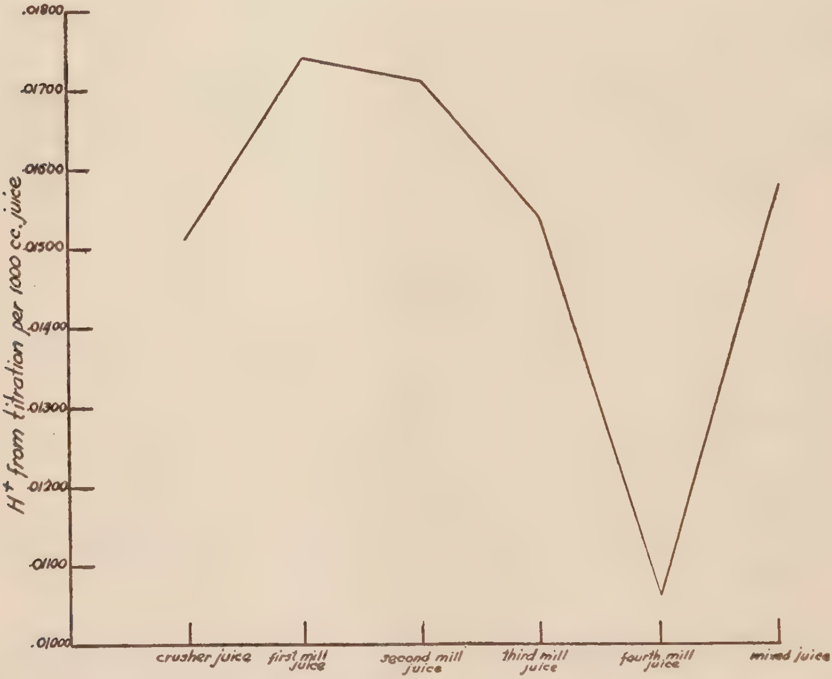
Table 13 shows the increase in acidity from titration, pH determinations, and acidity per 100 Brix solids from crusher juice on Tuesday to fourth mill juice on Sunday using the data of Sunday of the fourth mill juice as base.

Table 14 shows the results obtained in Hawaii relative to the Brix, acidity per 100 cc., and acidity per 100 Brix solids from the first to fourth mills.

Table 15 gives the data obtained by Paine and Balch in their work in Cuba. The table shows the pH and Brix for the various units of the milling plant.

DISCUSSION OF RESULTS

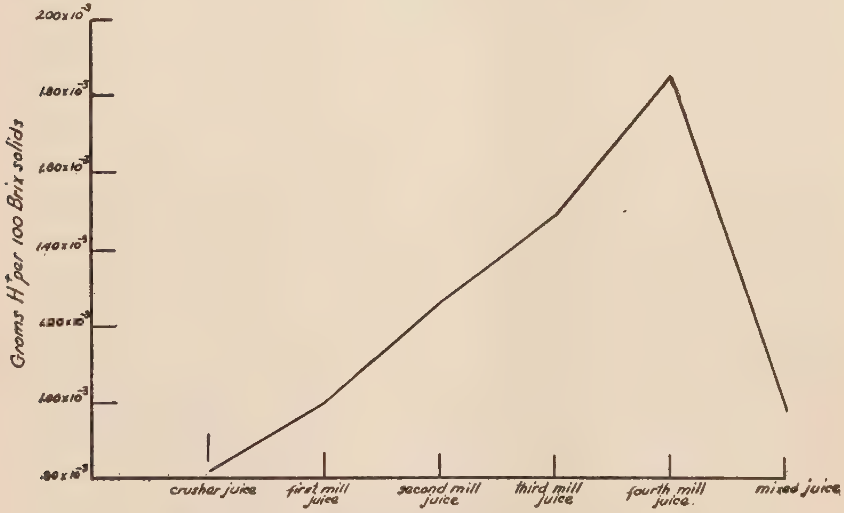
A study of the tabulated results of the acidity determinations given in tables 4 to 9 and summarized in graph 1 indicates very clearly that there is a greater increase in total acidity of the first mill juice than of the crusher juice. It may be seen that from the first mill to the last mill the hydrogen ion concentration, that is, grams of hydrogen ion per 1,000 cc. shows a decided drop. That is, in the juices expressed by the second, third, and fourth mills there is a decrease in the acidity. The hydrogen ion is slightly higher in the mixed juice than in the crusher. The increase in acidity of juice from the crusher to first mill must be explained not on the basis of bacterial decomposition but on the basis of rind juice extraction by pressure. According to Deerr (1921) this rind juice contains acid salts which on hydrolysis give acids. Experiments conducted by Deerr (1921) indicate that the hydrogen ion concentration of the rind juice is greater than that of the pith juice. It seems impossible that in the space of a few minutes bacteria could produce an average increase of .00238 gram of hydrogen ion per liter or .1428 gram acetic acid per liter.



Graph 2.—Relationship between average hydrogen ion concentration from pH determination and mill unit.

Study of the tabulated results and graph 1 indicate that with the return of the fourth mill juice before that of the third mill and the return of the third mill juice before that of the second mill, there is a decided decrease in grams hydrogen ion per liter from the first mill to the last mill. The water applied before the fourth mill was a mixture of artesian well water and condensates from the evaporators. It is impossible to ascribe the constant decrease of grams hydrogen ion per liter and increase in pH to bacterial decomposition.

The graphs 1, 2, and 4 and the tabulated data upon which these graphs were based indicate that there is no increase in acidity during the milling when a neutral maceration water is applied and the mill housing, pit, and rollers are thoroughly washed once a day and the bagasse accumulations removed once an hour. Contrary to reports by other investigators the pH of the fourth, third, and second mill juices is greater than that of the crusher juice.



Graph 3.—Relationship between average grams hydrogen ion concentration per 100 Brix solids and mill unit.

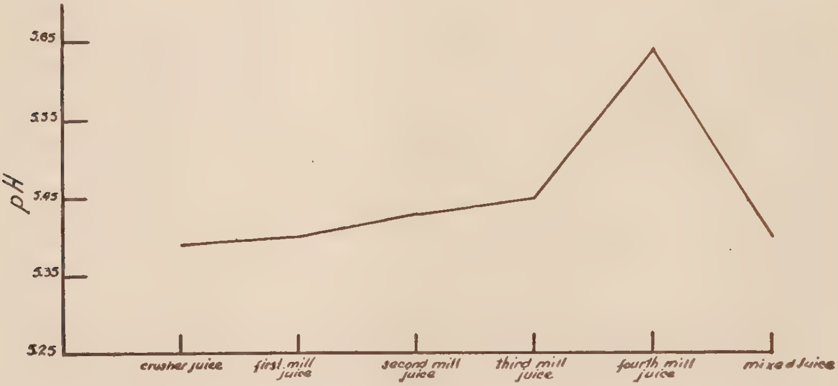
Data given on graph 2 and in the tabulated results indicate that the hydrogen ion concentration, or the potential acidity shows a continued decrease from the crusher juice to that of the last mill and that the mixed juice has a lower potential acidity than that of the crusher juice.

The average crusher juice hydrogen ion concentration was 4.03×10^{-6} that is, .00000403 grams per liter, while the last mill juice had an average hydrogen ion concentration or 2.30×10^{-6}. This decrease in hydrogen ion does not indicate an increase in acidity of juice from crusher to last mill.

The mixed juice analysis shows an average hydrogen ion of 3.87×10^{-6} per liter of juice. From these average data it would appear that the hydrogen ion concentration of the mixed juice decreased from that of the crusher by $.16 \times 10^{-6}$ grams per liter. The last mill juice showed the greatest drop of all, that is from 4.03×10^{-6} grams hydrogen ion per liter to 2.3×10^{-6} a decrease of 1.73×10^{-6}.

Referring to graph 1, it appears that there is an increase in total acidity of juice from crusher to first mill and a drop in total acidity from first mill to last mill, with an increase in total acidity in juice.

Graph 3 which is based upon table 1, indicates that there is a very rapid increase in grams of hydrogen ion per liter when a comparison is made upon the Brix solids. A further study of these data will show that the solids rapidly decrease with each milling unit. If a constant number is divided by a decreasing smaller one, a correspondingly increasing quotient will be obtained. The published comparisons of acidity per hundred Brix are erroneous as the potential acidity capable of inversion is not a function of the total solids but of the concentration per liter.



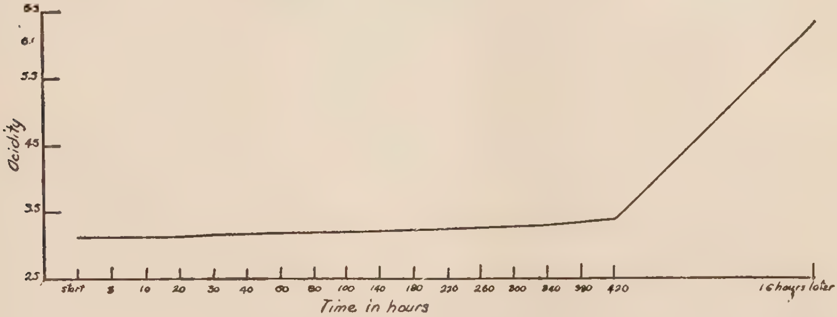
Graph 4.—Relationship between average pH and mill unit.

Graph 4 and the tabulated results in table 1 show that there is an increase in pH from the crusher juice to that of the fourth mill from pH 5.39 to pH 5.64. This increase shows that there is a decrease in acidity from the crusher juice to that of the fourth mill juice. The pH of the mixed juice dropped to 5.40 which equals the pH of the first mill juice.

Table 12 (on file) shows that there is no increase in acidity from the first day of the week to the last day of the week. This is because all bagasse accumulations, etc., were taken out from around the juice troughs so as to prevent inversion.

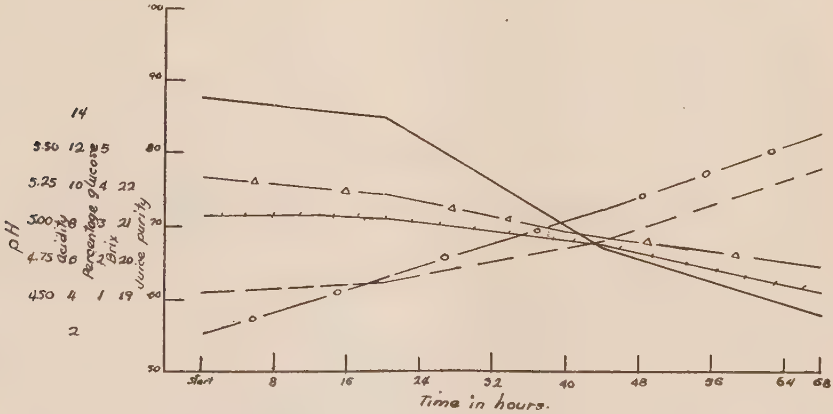
Seven determinations, given in table 3 and in graph 5, made on a sample of mill juice gave an average titrable acidity equivalent to 3.14 cc. of .1073 N sodium hydroxide. There was a gradual change due chiefly to bacterial action after the elapse of one hour. After a period of 16 hours the acidity had increased to 100 per cent, that is, from 3.14 to 6.41 cc. of .1073 N sodium hydroxide. From these data it is evident that to prevent souring the mills should be cleaned and the bagasse accumulations taken out once each shift.

The changes brought about by bacterial action and time shown in table 2 and graph 6 indicate that within a 68-hour period, the average pH of the juice changed from 5.31 to 4.75 and the titrable acidity from 2.2 cc. to 12.7 cc. of .1073 N sodium hydroxide or a 600 per cent increase. These data show that inversion takes place without a corresponding loss of glucose. In this investigation the glucose increased from 1.21 to 4.61 per cent while the sucrose dropped from 18.67 to 9.77. This indicates that the loss may be very great if bagasse accumulations and stagnant pools of juice are not removed.



Graph 5.—Relationship between acidity and time.

During a 20-hour period, the loss was not great. It appears that there is a 12-hour margin of safety before juices rapidly deteriorate.

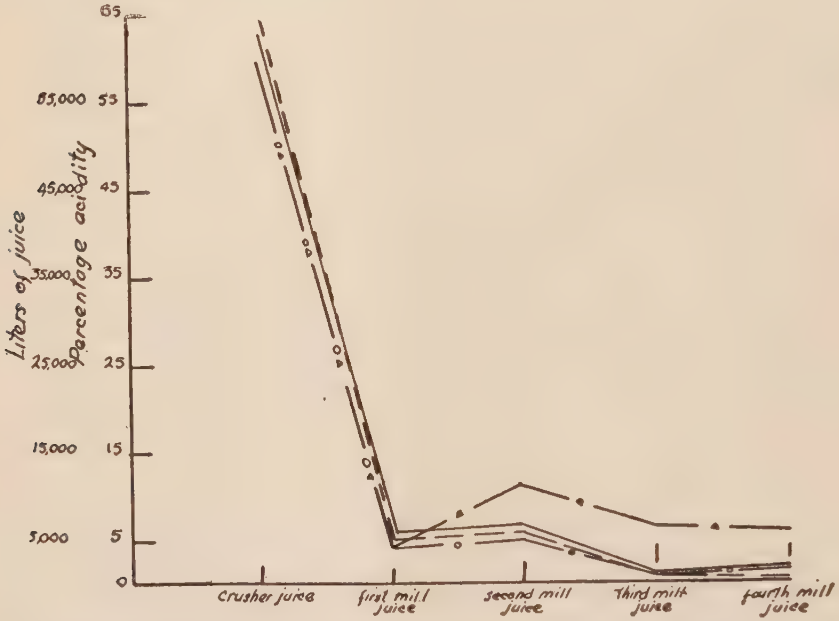


Graph 6.—Curves showing relationship between pH, acidity, percentage glucose, Brix, juice purity, and time.

Legend

–Δ–Δ– pH
–o–o– acidity
– – – percentage glucose
_|_|_|_|_|_ Brix
——— juice purity

From theoretical considerations there was obtained, using average figures for the whole period, an increase of 20.21 per cent or a difference of 226.49 grams of hydrogen ion per 100 tons of cane ground over and above that obtained by calculation. Using these theoretical calculations based upon average titrations, the mixed juice shows an increase of acidity over the theoretical of 28.49 per cent, or 319.33 grams hydrogen ion per 100 tons cane. That acidity development takes place after the juice leaves the mill was shown by the difference between 1440.24 grams hydrogen ion and 1353.40 grams hydrogen ion which is 92.84 grams hydrogen ion or 6.89 per cent increase.



Graph 7.—Curves showing relationship between liters of juice, percentage acidity, and mill unit.

Legend

———	Percentage acidity in mixed juice by titration extracted by milling units.
— — –	Percentage acidity in mixed juice by pH determinations extracted by milling units.
—o—	Volume of normal juice in different units of a milling plant.
- - -^- - -	Volume of actual juice in different units of milling plant.

SUMMARY AND CONCLUSIONS

1. In a Philippine sugar central an investigation involving 1,728 determinations on the total acidity by titration, actual acidity or pH by quinhydrone electrode, and Brix solids of the juices coming from each individual milling plant was made.

2. This investigation showed that there was no increase in total grams of hydrogen ion per liter from crusher juice to that of last mill when the following sanitary measures were followed:

   (*a*) The mills were thoroughly washed down once every shift.

   (*b*) Bagasse accumulations were removed from the juice troughs and pit.

3. There is an increase in total acidity in the mixed juice greater than that of the crusher juice.

4. There is an increase in total acidity in the first mill juice greater than that of the crusher juice.

5. The use of artesian well water and condensate from first effect or hot well water on the last mill and the return of the third and fourth mill juices ahead of the second mill resulted in an average lower total acidity, or grams of hydrogen ion per liter in the second mill juice as compared with first mill juice.

6. The possibility of destruction of sucrose by bacterial action in the juice remaining in the bagasse from the crusher to the last mill is remote.

7. The increase in acidity from the crusher to first mill cannot be due to bacterial action as the time of extraction is less than half a minute. This increase is due to the expression of acids from the rind of the cane by the heavy pressure in the first mill.

8. Large amounts of sucrose were lost if the juice was allowed to stand more than 24 hours.

9. Theoretical and actual estimates of acidity, that is, grams hydrogen ion per 100 tons cane showed that under normal operating conditions an increase in acidity of 20.21 per cent was to be expected when the acidity of the first mill juice was used as a standard.

10. An increase of 6.89 per cent, or 92.84 grams hydrogen ion in the mixed juice per 100 tons of cane over the calculated acidity from all mills indicates that there was bacterial action in the juice after it left the mills.

11. Where the mills were thoroughly washed down once every shift and bagasse accumulations periodically removed, the acidity, that is, grams hydrogen ion per liter due to bacterial action was negligible.

12. The use of chemicals or lime water is not advisable in cleaning the mills owing to the small increase of the actual acidity of juice over the theoretical total acidity of the normal juice.

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TABLE 1—(SECTION 1)

Summarized data of acidity increase, pH, grams H+ concentration per 100 Brix solids. Brix for various units of the milling plant juice, purities, and other mill data

PERIOD	CRUSHER JUICE					
	cH + from titration per 1000 cc.	cH + from pH determination	Corres. pH	Grams H + per 100 Brix solids	Cor. Brix	Ap. purity
Daily av.	.01762	3.56×10^{-6}	5.45	$.97\times10^{-3}$	17.12	83.3
	.01334	3.32×10^{-6}	5.48	$.75\times10^{-3}$	17.12	84.8
	.01334	2.76×10^{-6}	5.56	$.77\times10^{-3}$	17.12	84.8
	.01161	3.31×10^{-6}	5.48	$.62\times10^{-3}$	17.45	84.0
Weekly av.	.01431	3.24×10^{-6}	5.49	$.78\times10^{-3}$	17.20	84.2
Daily av.	.01425	3.62×10^{-6}	5.44	$.82\times10^{-3}$	16.62	84.3
	.01539	3.65×10^{-6}	5.44	$.89\times10^{-3}$	17.12	84.7
	.01505	3.73×10^{-6}	5.43	$.82\times10^{-3}$	17.09	85.2
	.01453	5.52×10^{-6}	5.26	$.81\times10^{-3}$	16.76	83.2
	.01583	4.51×10^{-6}	5.34	$.95\times10^{-3}$	16.31	83.8
	.01536	4.37×10^{-6}	5.36	$.82\times10^{-3}$	17.45	84.1
Weekly av.	.01507	4.24×10^{-6}	5.37	$.84\times10^{-3}$	16.89	84.3
Daily av.	.01228	4.26×10^{-6}	5.37	$.70\times10^{-3}$	16.52	84.1
	.01623	3.88×10^{-6}	5.41	$.94\times10^{-3}$	16.20	86.3
	.01392	3.74×10^{-6}	5.43	$.75\times10^{-3}$	16.92	84.9
	.01571	2.94×10^{-6}	5.53	$.86\times10^{-3}$	17.07	85.9
	.01808	2.68×10^{-6}	5.57	$.98\times10^{-3}$	17.53	85.6
	.01505	2.86×10^{-6}	5.54	$.79\times10^{-3}$	17.75	85.5
Weekly av.	.01521	3.40×10^{-6}	5.47	$.84\times10^{-3}$	16.99	85.4
Daily av.	.01662	3.85×10^{-6}	5.55	$.89\times10^{-3}$	17.44	83.3
	.01709	4.86×10^{-6}	5.31	$.93\times10^{-3}$	17.09	85.4
	.01465	4.16×10^{-6}	5.38	$.78\times10^{-3}$	17.62	85.6
	.01427	4.17×10^{-6}	5.38	$.74\times10^{-3}$	17.85	85.3
	.01663	5.03×10^{-6}	5.30	$.86\times10^{-3}$	17.96	84.5
	.01387	4.14×10^{-6}	5.38	$.73\times10^{-3}$	18.04	84.0
Weekly av.	.01552	4.37×10^{-6}	5.36	$.82\times10^{-3}$	17.66	84.7
Daily av.	.01584	4.32×10^{-6}	5.36	$.83\times10^{-3}$	17.93	84.0
	.01281	4.15×10^{-6}	5.38	$.69\times10^{-3}$	17.44	85.6
	.01399	4.22×10^{-6}	5.37	$.72\times10^{-3}$	18.26	86.1
	.01663	4.84×10^{-6}	5.31	$.86\times10^{-3}$	17.97	87.6
	.01689	5.82×10^{-6}	5.32	$.95\times10^{-3}$	16.82	86.3
	.01360	3.89×10^{-6}	5.31	$.72\times10^{-3}$	17.62	85.9
Weekly av.	.01496	4.64×10^{-6}	5.34	$.80\times10^{-3}$	17.67	85.9
Daily av.	.01756	3.89×10^{-6}	5.31	$.97\times10^{-3}$	17.12	83.8
	.01412	4.35×10^{-6}	5.34	$.74\times10^{-3}$	17.80	87.0
	.01510	3.97×10^{-6}	5.40	$.82\times10^{-3}$	17.25	85.7
	.01346	3.79×10^{-6}	5.42	$.71\times10^{-3}$	17.74	86.3
	.01689	4.11×10^{-6}	5.39	$.78\times10^{-3}$	17.36	86.4
	.01558	3.56×10^{-6}	5.45	$.87\times10^{-3}$	16.74	86.4
Weekly av.	.01504	3.98×10^{-6}	5.40	$.82\times10^{-3}$	17.33	85.9
Whole period av.	.01508	4.03×10^{-6}	5.39	$.82\times10^{-3}$	17.29	85.07

TABLE 1—(SECTION 2)

Summarized data of acidity increase, pH, grams H+ concentration per 100 Brix solids. Brix for various units of the milling plant juice, purities, and other mill data

PERIOD	1ST MILL JUICE				
	cH+ from titration per 1000 cc.	cH+ from pH determination	Corres. pH	Grams H+ per 100 Brix solids	Cor. Brix
Daily av.	.01976	3.11×10^{-6}	5.51	1.14×10^{-3}	16.39
	.01583	2.79×10^{-6}	5.56	$.89\times10^{-3}$	16.77
	.01716	2.54×10^{-6}	5.59	$.98\times10^{-3}$	16.25
	.01459	3.16×10^{-6}	5.50	$.81\times10^{-3}$	16.75
Weekly av.	.01698	2.88×10^{-6}	5.54	$.97\times10^{-3}$	16.54
Daily av.	.01818	3.56×10^{-6}	5.45	1.05×10^{-3}	16.29
	.01817	3.53×10^{-6}	5.45	1.02×10^{-3}	16.66
	.01796	3.29×10^{-6}	5.48	1.05×10^{-3}	15.97
	.01713	4.57×10^{-6}	5.34	$.99\times10^{-3}$	16.04
	.01906	3.93×10^{-6}	5.41	1.14×10^{-3}	16.11
	.01804	4.04×10^{-6}	5.39	$.99\times10^{-3}$	17.01
Weekly av.	.01808	3.82×10^{-6}	5.42	1.04×10^{-3}	16.34
Daily av.	.01440	3.98×10^{-6}	5.40	$.84\times10^{-3}$	15.90
	.01919	3.79×10^{-6}	5.42	1.13×10^{-3}	15.60
	.01804	3.54×10^{-6}	5.45	1.00×10^{-3}	16.87
	.01782	3.76×10^{-6}	5.43	1.01×10^{-3}	16.66
	.02454	3.10×10^{-6}	5.51	1.37×10^{-3}	17.98
	.01668	2.78×10^{-6}	5.56	$.89\times10^{-3}$	17.46
Weekly av.	.01845	3.49×10^{-6}	5.46	1.04×10^{-3}	16.62
Daily av.	.01901	5.09×10^{-6}	5.29	1.04×10^{-3}	17.05
	.01888	5.37×10^{-6}	5.27	1.07×10^{-3}	16.54
	.01639	4.17×10^{-6}	5.38	$.89\times10^{-3}$	17.18
	.01643	4.35×10^{-6}	5.36	$.87\times10^{-3}$	17.54
	.01919	5.66×10^{-6}	5.25	1.05×10^{-3}	17.28
	.01682	4.39×10^{-6}	5.36	$.94\times10^{-3}$	17.47
Weekly av.	.01779	4.84×10^{-6}	5.31	$.98\times10^{-3}$	17.18
Daily av.	.01996	4.11×10^{-6}	5.39	1.07×10^{-3}	17.48
	.01518	4.88×10^{-6}	5.31	$.84\times10^{-3}$	16.97
	.01584	4.38×10^{-6}	5.36	$.87\times10^{-3}$	17.14
	.01953	4.99×10^{-6}	5.30	1.06×10^{-3}	17.33
	.01954	5.77×10^{-6}	5.24	1.22×10^{-3}	15.15
	.01544	4.37×10^{-6}	5.36	$.84\times10^{-3}$	17.15
Weekly av.	.01758	4.75×10^{-6}	5.32	$.98\times10^{-3}$	16.87
Daily av.	.02038	3.79×10^{-6}	5.42	1.18×10^{-3}	16.47
	.01681	4.37×10^{-6}	5.36	$.90\times10^{-3}$	17.40
	.01666	3.81×10^{-6}	5.42	$.93\times10^{-3}$	16.79
	.01637	3.69×10^{-6}	5.43	$.87\times10^{-3}$	17.54
	.01822	3.97×10^{-6}	5.40	$.78\times10^{-3}$	16.75
	.01769	3.31×10^{-6}	5.48	1.00×10^{-3}	16.54
Weekly av.	.01769	3.82×10^{-6}	5.42	$.95\times10^{-3}$	16.91
Whole period av.	.01746	4.02×10^{-6}	5.40	1.00×10^{-3}	16.74

TABLE 1—(SECTION 3)

Summarized data of acidity increase, pH, grams H+ concentration per 100 Brix solids. Brix for various units of the milling plant juice, purities, and other mill data

PERIOD	2ND MILL JUICE				
	cH + from titration per 1000 cc.	cH + from pH determination	Corres. pH	Grams H + per 100 Brix solids	Cor. Brix
Daily av.	.01919	2.73×10^{-6}	5.56	1.28×10^{-3}	14.04
	.01491	2.36×10^{-6}	5.63	1.07×10^{-3}	13.39
	.01531	2.43×10^{-6}	5.61	1.22×10^{-3}	12.02
	.01373	2.80×10^{-6}	5.55	$.91\times10^{-3}$	14.05
Weekly av.	.01592	2.57×10^{-6}	5.59	1.13×10^{-3}	13.38
Daily av.	.01705	3.30×10^{-6}	5.48	1.26×10^{-3}	12.88
	.01661	3.37×10^{-6}	5.47	1.29×10^{-3}	12.26
	.01685	3.25×10^{-6}	5.49	1.29×10^{-3}	12.37
	.02176	4.29×10^{-6}	5.37	1.57×10^{-3}	12.75
	.01691	3.72×10^{-6}	5.43	1.25×10^{-3}	13.15
	.01577	3.76×10^{-6}	5.42	1.10×10^{-3}	13.61
Weekly av.	.01750	3.62×10^{-6}	5.44	1.30×10^{-3}	12.84
Daily av.	.01426	3.82×10^{-6}	5.42	1.08×10^{-3}	12.57
	.01795	3.58×10^{-6}	5.45	1.48×10^{-3}	11.62
	.01604	3.17×10^{-6}	5.50	1.12×10^{-3}	13.75
	.01836	3.34×10^{-6}	5.48	1.43×10^{-3}	12.38
	.01967	2.85×10^{-6}	5.55	1.58×10^{-3}	13.34
	.01452	2.88×10^{-6}	5.54	1.28×10^{-3}	15.33
Weekly av.	.01680	3.28×10^{-6}	5.49	1.33×10^{-3}	13.16
Daily av.	.01822	4.66×10^{-6}	5.33	1.32×10^{-3}	13.22
	.02080	4.58×10^{-6}	5.34	1.46×10^{-3}	13.42
	.01809	4.23×10^{-6}	5.37	1.24×10^{-3}	13.84
	.01739	4.43×10^{-6}	5.35	1.21×10^{-3}	13.61
	.01985	5.13×10^{-6}	5.29	1.25×10^{-3}	15.09
	.01665	4.04×10^{-6}	5.39	1.13×10^{-3}	14.06
Weekly av.	.01850	4.52×10^{-6}	5.35	1.27×10^{-3}	13.87
Daily av.	.01818	4.00×10^{-6}	5.31	1.23×10^{-3}	13.99
	.01499	4.82×10^{-6}	5.32	$.99\times10^{-3}$	14.48
	.01590	4.23×10^{-6}	5.37	1.12×10^{-3}	13.52
	.01808	4.75×10^{-6}	5.32	1.31×10^{-3}	13.32
	.01800	5.24×10^{-6}	5.28	1.24×10^{-3}	13.54
	.01602	4.89×10^{-6}	5.31	1.06×10^{-3}	14.23
Weekly av.	.01686	4.49×10^{-6}	5.35	1.16×10^{-3}	13.84
Daily av.	.01677	3.63×10^{-6}	5.44	1.49×10^{-3}	12.36
	.01642	4.12×10^{-6}	5.38	1.22×10^{-3}	12.84
	.01628	3.66×10^{-6}	5.44	1.06×10^{-3}	14.51
	.01426	3.47×10^{-6}	5.46	1.14×10^{-3}	13.91
	.01826	3.61×10^{-6}	5.44	1.30×10^{-3}	14.25
	.01716	3.12×10^{-6}	5.51	1.42×10^{-3}	12.64
Weekly av.	.01693	3.60×10^{-6}	5.44	1.29×10^{-3}	13.42
Whole period av.	.01712	3.76×10^{-6}	5.43	1.26×10^{-3}	13.42

TABLE 1—(SECTION 4)

Summarized data of acidity increase, pH, grams H+ concentration per 100 Brix solids. Brix for various units of the milling plant juice, purities, and other mill data

PERIOD	3RD MILL JUICE				
	cH+ from titration per 1000 cc.	cH+ from pH determination	Corres. pH	Grams H+ per 100 Brix solids	Cor. Brix
Daily av.	.01652	2.50×10^{-6}	5.60	1.55×10^{-3}	10.27
	.01240	2.24×10^{-6}	5.65	1.27×10^{-3}	9.51
	.01240	2.27×10^{-6}	5.64	1.40×10^{-3}	8.60
	.01144	2.71×10^{-6}	5.57	1.29×10^{-3}	8.59
Weekly av.	.01331	2.42×10^{-6}	5.62	1.39×10^{-3}	9.24
Daily av.	.01414	3.72×10^{-6}	5.49	1.48×10^{-3}	9.27
	.01400	3.16×10^{-6}	5.50	1.56×10^{-3}	8.54
	.01373	2.96×10^{-6}	5.53	1.48×10^{-3}	8.99
	.01563	4.16×10^{-6}	5.58	1.51×10^{-3}	9.82
	.01425	3.59×10^{-6}	5.45	1.55×10^{-3}	9.14
	.01320	3.51×10^{-6}	5.45	1.35×10^{-3}	9.45
Weekly av.	.01416	3.44×10^{-6}	5.46	1.49×10^{-3}	9.21
Daily av.	.01320	3.45×10^{-6}	5.46	1.39×10^{-3}	9.26
	.01551	3.24×10^{-6}	5.49	1.75×10^{-3}	8.72
	.01444	3.17×10^{-6}	5.50	1.36×10^{-3}	9.42
	.01596	3.23×10^{-6}	5.49	1.66×10^{-3}	9.37
	.01821	2.82×10^{-6}	5.55	1.64×10^{-3}	10.75
	.01452	2.68×10^{-6}	5.54	1.28×10^{-3}	10.81
Weekly av.	.01513	3.13×10^{-6}	5.50	1.52×10^{-3}	9.72
Daily av.	.01597	4.07×10^{-6}	5.39	1.52×10^{-3}	10.12
	.01650	4.09×10^{-6}	5.39	1.61×10^{-3}	9.88
	.01591	3.48×10^{-6}	5.46	1.37×10^{-3}	11.14
	.01571	4.09×10^{-6}	5.39	1.24×10^{-3}	12.04
	.01795	4.53×10^{-6}	5.34	1.43×10^{-3}	11.98
	.01611	3.72×10^{-6}	5.43	1.37×10^{-3}	12.22
Weekly av.	.01636	4.00×10^{-6}	5.40	1.43×10^{-3}	11.23
Daily av.	.01589	3.42×10^{-6}	5.47	1.50×10^{-3}	10.14
	.01432	4.46×10^{-6}	5.35	1.24×10^{-3}	11.08
	.01413	4.04×10^{-6}	5.39	1.22×10^{-3}	11.23
	.01613	4.21×10^{-6}	5.37	1.38×10^{-3}	11.64
	.01685	5.00×10^{-6}	5.30	1.37×10^{-3}	11.96
	.01630	3.82×10^{-6}	5.42	1.19×10^{-3}	13.16
Weekly av.	.01560	4.16×10^{-6}	5.38	1.32×10^{-3}	11.53
Daily av.	.01751	3.42×10^{-6}	5.47	1.54×10^{-3}	10.80
	.01518	3.86×10^{-6}	5.41	1.29×10^{-3}	11.22
	.01506	3.46×10^{-6}	5.46	1.30×10^{-3}	11.31
	.01426	3.47×10^{-6}	5.46	1.14×10^{-3}	11.96
	.01817	3.61×10^{-6}	5.44	1.39×10^{-3}	12.51
	.01702	3.12×10^{-6}	5.50	1.40×10^{-3}	11.39
Weekly av.	.01626	3.49×10^{-6}	5.45	1.35×10^{-3}	11.55
Whole period av.	.01543	3.52×10^{-6}	5.45	1.49×10^{-3}	10.41

TABLE 1—(SECTION 5)

Summarized data of acidity increase, pH, grams H+ concentration per 100 Brix solids. Brix for various units of the milling plant juice, purities, and other mill data

PERIOD	4TH MILL JUICE					
	cH+ from titration per 1000 cc.	cH+ from pH determination	Corres. pH	Grams H+ per 100 Brix solids	Cor. Brix	Ap. Purity
Daily av.	.01279	1.63×10^{-6}	5.78	2.09×10^{-3}	6.39	71.5
	.01055	1.78×10^{-6}	5.75	1.57×10^{-3}	6.53	76.3
	.00924	1.86×10^{-6}	5.73	1.69×10^{-3}	5.37	76.6
	.00966	2.02×10^{-6}	5.70	1.47×10^{-3}	6.31	73.7
Weekly av.	.01062	1.82×10^{-6}	5.73	1.73×10^{-3}	6.15	74.5
Daily av.	.01093	2.76×10^{-6}	5.56	1.84×10^{-3}	5.87	73.7
	.01043	2.23×10^{-6}	5.65	2.02×10^{-3}	5.18	75.9
	.01016	2.75×10^{-6}	5.65	1.99×10^{-3}	5.02	75.9
	.01029	2.99×10^{-6}	5.52	2.04×10^{-3}	5.07	75.2
	.01056	3.22×10^{-6}	5.49	2.10×10^{-3}	5.06	75.9
	.00990	2.67×10^{-6}	5.57	1.94×10^{-3}	4.97	75.9
Weekly av.	.01038	2.69×10^{-6}	5.57	1.99×10^{-3}	5.19	75.4
Daily av.	.00950	2.75×10^{-6}	5.56	1.42×10^{-3}	5.53	75.8
	.01093	2.60×10^{-6}	5.58	1.97×10^{-3}	5.41	75.2
	.01029	2.38×10^{-5}	5.62	1.83×10^{-3}	5.49	75.7
	.01173	2.36×10^{-6}	5.63	2.05×10^{-3}	5.53	76.8
	.01254	2.47×10^{-6}	5.61	2.10×10^{-3}	6.07	77.5
	.01122	1.97×10^{-6}	5.71	1.94×10^{-3}	5.62	75.9
Weekly av.	.01104	2.42×10^{-6}	5.62	1.93×10^{-3}	5.61	76.2
Daily av.	.01162	2.04×10^{-6}	5.69	2.00×10^{-3}	5.66	74.1
	.01307	2.60×10^{-6}	5.58	1.99×10^{-3}	5.67	76.4
	.01096	2.36×10^{-6}	5.63	1.69×10^{-3}	6.35	76.3
	.01096	2.64×10^{-6}	5.58	1.55×10^{-3}	6.90	76.9
	.01201	2.61×10^{-6}	5.58	1.79×10^{-3}	6.46	75.7
	.01199	2.39×10^{-6}	5.62	1.85×10^{-3}	6.40	76.7
Weekly av.	.01177	2.44×10^{-6}	5.61	1.81×10^{-3}	6.24	76.0
Daily av.	.01109	1.95×10^{-6}	5.71	1.65×10^{-3}	5.66	73.7
	.00924	2.44×10^{-6}	5.61	1.63×10^{-3}	5.11	75.3
	.01029	2.10×10^{-6}	5.68	2.01×10^{-3}	5.02	78.2
	.00963	1.93×10^{-6}	5.72	1.74×10^{-3}	5.25	79.0
	.01056	2.96×10^{-6}	5.53	1.94×10^{-3}	5.38	77.6
	.01156	2.59×10^{-6}	5.59	1.64×10^{-3}	7.05	76.6
Weekly av.	.01036	2.33×10^{-6}	5.63	1.81×10^{-3}	5.58	76.8
Daily av.	.01069	1.72×10^{-6}	5.77	2.03×10^{-3}	5.11	73.0
	.00858	1.73×10^{-6}	5.76	1.64×10^{-3}	5.03	77.0
	.00950	2.23×10^{-6}	5.65	1.90×10^{-3}	4.93	76.8
	.00963	2.17×10^{-6}	5.66	1.79×10^{-3}	5.49	78.2
	.01069	2.36×10^{-6}	5.63	1.74×10^{-3}	6.13	77.4
	.01056	2.03×10^{-6}	5.69	1.82×10^{-3}	5.02	78.3
Weekly av.	.00994	2.04×10^{-6}	5.69	1.83×10^{-3}	5.28	76.8
Whole period	.01067	2.20×10^{-6}	5.64	1.85×10^{-3}	5.67	75.88

TABLE 1—(SECTION 6)

Summarized data of acidity increase, pH, grams H+ concentration per 100 Brix solids· Brix for various units of the milling plant juice, purities, and other mill data

PERIOD	MIXED JUICE					
	cH + from titration per 1000 cc.	cH + from pH determination	Corres. pH	Grams H + per 100 Brix solids	Cor. Brix	Ap. purity
Daily av.	.01765	2.26×10^{-6}	5.65	1.09×10^{-3}	15.49	81.5
	.01438	2.94×10^{-6}	5.53	$.89\times10^{-3}$	15.11	83.4
	.01400	2.33×10^{-6}	5.63	1.18×10^{-3}	14.78	83.5
	.01249	2.86×10^{-6}	5.54	$.76\times10^{-3}$	15.41	82.5
Weekly av.	.01478	2.58×10^{-6}	5.59	1.00×10^{-3}	15.19	82.7
Daily av.	.01559	3.68×10^{-6}	5.43	1.01×10^{-3}	14.74	83.1
	.01518	3.36×10^{-6}	5.47	$.93\times10^{-3}$	15.23	83.9
	.01537	3.77×10^{-6}	5.42	$.97\times10^{-3}$	14.95	83.7
	.01493	4.37×10^{-6}	5.47	$.99\times10^{-3}$	14.22	81.3
	.01526	4.99×10^{-6}	5.40	1.02×10^{-3}	13.89	82.8
	.01492	3.55×10^{-6}	5.45	$.93\times10^{-3}$	15.04	82.4
Weekly av.	.01521	3.79×10^{-6}	5.42	$.98\times10^{-3}$	14.84	82.9
Daily av.	.01347	3.55×10^{-6}	5.45	$.88\times10^{-3}$	14.42	82.4
	.01566	3.99×10^{-6}	5.40	1.06×10^{-3}	14.11	85.3
	.01558	3.65×10^{-6}	5.44	1.04×10^{-3}	15.22	83.7
	.01631	3.31×10^{-6}	5.48	1.01×10^{-3}	15.23	84.2
	.01928	3.02×10^{-6}	5.52	1.19×10^{-3}	15.52	84.5
	.01833	3.30×10^{-6}	5.48	$.98\times10^{-3}$	15.32	84.0
Weekly av.	.01602	3.47×10^{-6}	5.46	1.03×10^{-3}	14.97	83.9
Daily av.	.01604	4.48×10^{-6}	5.35	$.98\times10^{-3}$	15.38	81.7
	.01558	4.28×10^{-6}	5.37	$.96\times10^{-3}$	15.36	84.1
	.01599	4.07×10^{-6}	5.39	$.97\times10^{-3}$	15.44	83.3
	.01544	4.61×10^{-6}	5.44	$.91\times10^{-3}$	15.99	84.0
	.01689	4.88×10^{-6}	5.31	$.99\times10^{-3}$	16.04	83.1
	.01519	4.21×10^{-6}	5.38	$.95\times10^{-3}$	15.41	82.5
Weekly av.	.01586	4.22×10^{-6}	5.38	$.96\times10^{-3}$	15.60	83.1
Daily av.	.01598	4.14×10^{-6}	5.38	$.91\times10^{-3}$	16.46	83.0
	.01439	4.79×10^{-6}	5.32	$.85\times10^{-3}$	15.73	84.0
	.01465	4.06×10^{-6}	5.39	$.86\times10^{-3}$	16.08	83.7
	.01610	4.98×10^{-6}	5.30	$.92\times10^{-3}$	16.36	86.0
	.01743	5.91×10^{-6}	5.25	1.04×10^{-3}	15.88	85.1
	.01402	4.52×10^{-6}	5.34	$.81\times10^{-3}$	16.32	84.1
Weekly av.	.01545	4.75×10^{-6}	5.32	$.90\times10^{-3}$	16.14	84.3
Daily av.	.01783	3.78×10^{-6}	5.42	1.11×10^{-3}	15.24	82.9
	.01465	4.22×10^{-6}	5.37	$.89\times10^{-3}$	15.49	85.7
	.01576	3.79×10^{-6}	5.42	$.98\times10^{-3}$	15.14	84.1
	.01492	3.51×10^{-6}	5.45	$.99\times10^{-3}$	16.28	84.6
	.01571	4.00×10^{-6}	5.39	$.92\times10^{-3}$	16.12	85.2
	.01641	3.38×10^{-6}	5.47	1.05×10^{-3}	15.22	85.4
Weekly av.	.01558	3.78×10^{-6}	5.42	$.99\times10^{-3}$	15.58	84.6
Whole period av.	.01575	3.87×10^{-6}	5.40	$.97\times10^{-3}$	15.39	83.58

TABLE 1—(SECTION 7)

Summarized data of acidity increase, pH, grams H+ concentration per 100 Brix solids Brix for various units of the milling plant juice, purities, and other mill data

PERIOD	MIXED JUICE—(CONTINUED)				
	Per cent fiber in cane	Per cent fiber in bagasse	Extraction	Maceration per cent cane	Tons cane per hour
Daily av.	10.65	47.45	93.44	14.68	69.62
	10.62	47.23	93.20	13.88	76.14
	10.60	47.53	93.18	14.07	67.76
	10.51	47.39	93.42	15.43	62.76
Weekly av.	10.59	47.40	93.31	14.51	69.07
Daily av.	10.82	47.58	93.41	13.89	69.28
	10.69	47.90	93.78	16.48	74.77
	10.65	47.52	93.55	15.20	74.77
	10.64	47.64	93.54	14.70	74.92
	10.71	47.55	93.55	14.39	75.54
	10.70	47.45	93.52	15.82	74.17
Weekly av.	10.70	47.61	93.59	14.96	73.91
Daily av.	10.73	47.02	93.63	15.28	75.65
	10.84	46.53	93.22	13.67	75.41
	10.84	46.48	93.30	14.64	78.47
	11.00	46.82	93.56	14.76	76.92
	10.87	46.84	93.35	13.79	75.69
	10.84	46.86	93.43	14.96	73.78
Weekly av.	10.85	46.76	93.41	14.55	75.98
Daily av.	10.76	46.84	93.40	12.35	80.21
	10.87	46.79	93.55	11.16	81.80
	10.87	46.39	93.24	10.22	79.84
	10.87	46.50	93.31	11.22	83.91
	10.80	46.64	93.57	11.93	79.82
	10.83	46.42	93.30	10.48	78.69
Weekly av.	10.83	46.59	93.41	11.23	80.10
Daily av.	10.75	47.45	93.86	13.20	69.87
	10.81	46.97	93.65	12.82	75.66
	10.81	47.32	93.48	13.15	77.42
	10.83	46.88	93.22	12.04	85.03
	10.84	47.31	93.59	13.26	80.32
	10.80	47.08	93.61	11.96	89.84
Weekly av.	10.81	47.17	93.57	12.74	79.69
Daily av.	10.88	47.63	93.74	14.91	75.14
	10.86	47.77	93.76	14.18	77.20
	10.63	47.68	93.84	13.12	77.84
	10.73	47.40	93.73	12.62	75.75
	10.40	47.70	93.78	11.27	81.11
	10.46	46.37	93.62	14.22	78.80
Weekly av.	10.66	47.44	93.74	13.39	77.64
Whole period av.	10.74	47.16	93.51	13.56	76.09

TABLE 2

Characteristics of cane juices held without heat or lime treatment

TIME OF ANALYSIS	BRIX	TEMP.	COR. BRIX	DIRECT READING	POL'N.	AP. PURITY	GLUCOSE	ACIDITY	pH
		°C.			*per cent*		*per cent*		
	21.2	29	21.31	77.8	18.66	87.56	1.21	2.2	5.31
At start.........	21.2	28.5	21.28	77.9	18.68	87.78	1.20	2.2	5.31
Average.........	21.2	28.8	21.30	77.85	18.67	87.67	1.21	2.2	5.31
	21.4	26	21.3	76.3	18.30	85.92	1.34	3.95	5.29
12 hours later...	21.4	26	21.3	76.3	85.30	85.92	1.33	4.00	5.29
Average.........	21.4	26	21.3	76.3	18.30	85.92	1.34	3.98	5.29
	21.2	28	21.26	75.4	18.12	85.23	1.40	5.2	5.24
8 hours later....	21.2	28	21.26	75.4	18.12	85.23	1.42	5.4	5.24
Average.........	21.2	28	21.26	75.4	18.12	85.23	1.41	5.3	5.24
	20.4	29	20.51	57.2	13.78	67.19	2.78	9.1	4.98
24 hours later...	20.4	28.5	20.47	57.0	13.73	67.07	2.82	9.4	4.89
Average.........	20.4	28.8	20.49	57.1	13.76	67.13	2.80	9.25	4.94
	19.1	29	19.21	40.4	9.79	50.96	4.66	12.6	4.77
24 hours later...	19.1	29	19.21	40.2	9.74	50.70	4.57	12.8	4.73
Average.........	19.1	29	19.21	40.3	9.77	50.83	4.61	12.7	4.75

TABLE 3

Titrable acidity increase in cane juice with time

SAMPLES	AT START CC. NaoH USED	5 MIN. LATER CC. NaoH	10 MIN. LATER CC. NaoH	20 MIN. LATER CC. NaoH	30 MIN. LATER CC. NaoH	45 MIN. LATER CC. NaoH	60 MIN. LATER CC. NaoH	75 MIN. LATER CC. NaoH	100 MIN. LATER CC. NaoH	120 MIN LATER CC. NaoH	16 HOURS LATER CC. NaoH
1	3.00	3.00	3.00	3.05	3.05	3.05	3.05	3.10	3.10	3.20	6.40
2	3.00	3.00	3.00	3.05	3.05	3.05	3.10	3.10	3.15	3.25	6.75
3	3.00	3.00	3.00	3.00	3.05	3.05	3.05	3.05	3.10	3.20	7.55
4	3.30	3.30	3.30	3.30	3.35	3.35	3.40	3.45	3.75	3.80	5.75
5	3.30	3.30	3.30	3.35	3.30	3.35	3.40	3.45	3.75	3.80	5.65
6	3.20	3.20	3.20	3.24	3.25	3.25	3.25	3.30	3.30	3.41	6.45
7	3.20	3.20	3.20	3.22	3.22	3.23	3.24	3.29	3.31	3.42	6.30
Average	3.14	3.14	3.14	3.17	3.18	3.19	3.21	3.25	3.30	3.44	6.41

THE COST OF PRODUCING PORK FROM SPAYED FEMALES, GILTS NOT ALLOWED TO BREED, AND SOW GILTS ALLOWED TO PRODUCE THEIR FIRST LITTER[1]

CLAUDIO G. ARELLANO

INTRODUCTION

By far the most important direct sources of pork placed in the market are the barrow and the gilt classes. Of these two classes, the barrow, being the more economical to feed and producing a superior quality of pork, has been the one preferred for fattening purposes.

With the feed and other items that make up the total cost of feeding tending to increase in price rather than to decrease, effort, for years, has been directed towards discovering ways and means to make pork production from female pigs as economical as from barrows, and more so if possible. As a result of these efforts some hog raisers fatten spayed females rather than open gilts. Others find it more profitable to allow them to produce their first litter before they are fattened.

As a hog raiser will have available as many females as barrows for fattening, he should know the best system of feeding and handling that, under his particular conditions, would secure the greatest profit.

The study herein reported is a part of an experiment conducted jointly with Valeriano S. Ong which was started on November 12, 1927 and closed January 7, 1929. Ong (1929) reported the results obtained from barrows, spayed females, and open gilts.

Review of past work

To the literature cited by Ong (1929), the following may be added:

Feliciano (1925) found that the average grain feed consumed by a sow during the gestation period was 130 kgm. and during the lactation period 164.9 kgm.

Bayan (1925) found that the total cost, including all possible expenses involved in the operation of producing pork from weanling to finished condition, was ₱.674 for one kgm. live weight pork. Also, he observed that it required 5.9 kgm. of feed mixture to produce one kgm. gain.

Ong (1929) reported that there was no appreciable difference in the cost of fitting for market of barrows, gilts, and spayed females.

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[1] Thesis presented for graduation, 1930, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 326; Experiment Station contribution No. 706. Prepared in the Department of Animal Husbandry under the direction of Dr. Mariano Mondoñedo.

Object of the experiment

The object of the part of the experiment reported in this paper was to obtain information on the profit of producing pork from gilts that were utilized for the production of one litter before they were fattened for market and comparing this profit with that obtained by producing pork from spayed females and open gilts.

MATERIALS AND METHODS

The animals used in this work were part of the same lot of purchased pigs used by Ong. There were twenty pigs for the experiment of which five were barrows, the remaining fifteen were females. These pigs were divided as uniformly as possible into three lots of five pigs each. The pigs in lot I were spayed, those in lot II were open gilts, and the lot III pigs were first utilized to produce a litter of pigs before they were fattened.

As details as to the rations used, the care and management followed, and the determination of cost figures were fully described by Ong they will be omitted here.

Each one of the five gilts composing lot III were bred. For five services ₱10.00 was charged against the lot.

RESULTS

1. Because the gilts were allowed to produce a litter before they were placed on the market, it was 422 days before they were ready for slaughter. This was 114 days longer than lot I (spayed) and 100 days longer than lot II (open gilts) were kept.

2. The young sows (lot III) consumed 523.61 kgm. of concentrates worth ₱37.07; the spayed (lot I) 303.67 kgm. worth ₱19.78; and the open gilts (lot II) 328.20 kgm. worth ₱22.35.

3. While the total cost of ₱291.99 required to maintain lot III was increased 68.33 per cent over the average cost of lots I and II (₱173.46), the amount made by the sows and their litters of lot III combined, was 21.77 per cent more than that average amount made by lot I and 58.3 per cent more than the average value made by lots I and II.

4. It was intended that the five female pigs would produce litters; but only four of them did.

5. Assuming that the gains made by the sows, sold for ₱.60 a kgm. and the gain made by the litter for ₱1.00 a kgm., lot III made an average profit of ₱11.22 a sow. The profit per pig of lot I was ₱9.20, of lot II, ₱9.98. Lot III, therefore, made a profit of ₱2.02 more than lot I and ₱1.24 more than lot II.

TABLE 1

Showing the total and average weight of pigs at the end of each 70-day period

	LOT I SPAYED FEMALES		LOT II GILTS		LOT III SOWS	
	Total weights	Average weight	Total weight	Average weight	Total weight	Average weight
	kgm.	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*
Initial weight Nov. 12, 1927	37.0	7.40	37.0	7.40	37.0	7.40
Weight at end 1st 70-day period	42.6	10.65	68.2	13.64	73.42	14.48
Weight at end 2nd 70-day period	101.9	20.38	131.0	26.20	139.70	27.94
Weight at end 3rd 70-day period	189.4	47.35	239.8	47.96	269.3	53.86
Weight at end 4th 70-day period	279.3	69.83	332.5	66.50	358.7	71.74
Weight at end 5th 28-day period	321.6	80.40				
Weight at end 5th 42-day period			401.0	80.22		
Weight at end 5th 70-day period					504.5	100.90
Weight at end 6th 70-day period					364.6	72.92

DISCUSSION OF RESULTS

Table 1 shows that the first two lots were declared finished for the market at a weight of 80 kgm. or thereabouts. The reason the 80 kgm. weight was selected as the market weight, is that experience in the Philippines has shown that this is the most convenient size for the butcher; also, the majority of the animals attain a prime condition and the maximum economy of growth at this weight under average feeding and care. In the case of lot III the 80 kgm. size was not the chief consideration, but the condition (degree of fatness) and the economy of the gains made. The pigs in this lot attained these requirements at 73 kgm. weight. They would have gained more with profit beyond this weight but they were then in the best condition for slaughter and the profit per kgm. gain in weight was diminishing.

It may be noted in table 1 that the pigs in lot III made greater and more rapid gains in the fourth and fifth periods than in the earlier periods. These gains coincided with the time when the gilts were pregnant and the decline in weight during the sixth period occurred at the time of nursing. Actually, there was gain made, not in the sows weight but in that of their litters, which the table does not show. Table 5 shows that the litters produced by the lot made a total gain in weight of 124.41 kgm. at weaning age, or an average of 24.88 kgm. an animal.

Table 2 shows that from the first to the fourth 70-day periods, inclusive, the amount and cost of feed consumed were essentially the same in all the lots. From the fifth to the sixth periods, lot III showed a rapid rate of increase in the amount of consumption. Little or no comparison could be made between this amount and that of each of the other lots from the fifth to the sixth period, because the first two lots reached the finished condition in the early part of the fifth 70-day period.

TABLE 2

Summary of the cost of feeding each pig for the market at different ages or periods of feeding

	LOT I		LOT II		LOT III	
	Feed	Cost	Feed	Cost	Feed	Cost
	kgm.	*pesos*	*kgm.*	*pesos*	*kgm.*	*pesos*
First period of 70 days	20.89	1.32	34.76	1.56	24.85	1.58
Second period of 70 days	33.74	2.39	48.20	3.40	52.98	3.77
Third period of 70 days	85.90	6.07	78.20	5.55	84.98	6.046
Fourth period of 70 days	102.82	6.55	82.56	5.85	86.28	6.140
Fifth period of 28 days (lot I)	60.32	3.45	——	——	——	——
Fifth period of 42 days (lot II)	——	——	84.48	5.99	——	——
Fifth period of 70 days (lot III)	——	——	——	——	145.44	10.348
Sixth period of 72 days (lot III)	——	——	——	——	129.08	9.184
	303.67	19.78	328.20	22.35	523.61	37.068

TABLE 3

Showing the average cost of feeding one pig of lot III for the market during the three different ages or periods

	NUMBER OF DAYS TO PREPARE FOR MARKET	ONE PIG	
		Feed, kgm.	Cost
Weaning to breeding	252	205.54	₱14.44
Breeding to farrowing	114	214.28	15.25
Farrowing to finished	56	103.76	7.38
Totals	422	523.58	37.07

Table 3 summarizes the cost of feeding each pig for the market at successive stages in lot III. It may be seen that from weaning to breeding, an average period of 252 days, the pigs consumed almost as much feed as they did during the succeeding period, that is, the gestation period of 114 days. During the nursing period, including a short fattening period following weaning, the lot consumed 103.7 kgm. of feed worth ₱7.38. During the nursing period the sows did not lose much weight; neither did they fall off much in condition. This was due largely to the excellent condition of the gilts during gestation and nursing; also they were given liberal feeding and pasturing and raised small litters. After the pigs were weaned it did not take more than a week to fatten the sows. Some of the pigs that were large and growthy were weaned and sold when six and seven weeks old; the rest were weaned when eight weeks old.

Table 4 shows partial results obtained in lot III in 70-day periods. Of particular interest is the amount and rate of gains made and the amount and cost of feed consumed as the pigs passed from one period to another. From the first to the fifth period there was a progressive increase in the

TABLE 4

Results in lot III for the 70-day periods of feeding

	1st, 70 days	2nd, 70 days	3rd, 70 days
Number of pigs	5	5	5
Average initial weight	7.40	14.48	27.94
Average final weight	14.48	27.94	53.86
Average gain or loss per pig	+ 7.084	+13.456	+25.92
Average daily gain per pig	+ .1012	+ .1921	+ .3703
Total grain consumed per pig	24.88	52.98	84.98
Total cost of grain consumed	₱7.91	₱18.848	30.236
Average daily grain consumed per pig	.497	1.0596	1.6996
Grain feed consumed per kgm. gain	3.51	3.94	3.28
Cost of grain to produce 1 kgm. gain	.2497	.2801	.2332

	4th, 70 days	5th, 70 days	6th, 72 days
Number of pigs	5	5	5
Average initial weight	53.86	71.74	100.8
Average final weight	71.74	100.80	72.92
Average gain or loss per pig	+17.88	+29.16	−27.9808
Average daily gain per pig	+ .2554	+ .4165	− .39408
Total grain consumed per pig	86.28	145.44	129.08
Total cost of grain consumed	30.64	51.74	45.92
Average daily grain consumed per pig	1.7256	2.908	1.79
Grain feed consumed per kgm. gain	4.83	4.99	(Sows
Cost of grain to produce 1 kgm. gain	.3433	.3548	lost weight)

amount of gains of 7.08, 13.46, 25.92, 17.88, and 29.16 kgm. They lost 27.98 kgm. in weight in the sixth period. This was incident to farrowing and nursing.

From one period to the next the cost of producing one kgm. gain showed a tendency to increase. The only exception was in the third period which was less than in the second. This was because at this time the pigs had access to camote pasture. The reason for this increase in the feed cost to make successive gains is that the proportion of the feed used for maintenance increases as the animals become older. It follows, of course, that the cost of gains made from one period to the next increases also.

Table 5 gives the total and final results obtained during the whole period of fitting the animals for the market.

The average final weight per pig in lot I was 80.4 kgm., in lot II 80.22 kgm., in lot III, only 72.19 kgm. But, add to this the 24.88 kgm. gain made by the weanlings, the total gain by lot III was 97.07 kgm. At 60 centavos a kgm., lot I produced pork, with an average value of ₱48.24 and lot II, ₱48.13. Lot III made only ₱43.31 worth of pork. But add to this, the selling value of 24.88 kgm. representing the weight of the weanling pigs, at ₱1.00 a kgm. or ₱24.88, the gross returns made by lot III was ₱68.18, making a net profit of ₱9.78 a pig against the average net profit of ₱11.03

for lot I and ₱9.98 for lot II. The difference is small but it shows a profitable method of fattening pigs when there is need for more pigs for fattening purposes.

TABLE 5

Summary of results obtained during the whole feeding trial

	LOT I SPAYED	LOT II GILT	LOT III SOW
Number of pigs	4	5	5
Duration of experiment	308 days	322 days	422 days
Total initial weight	37.00 kgm.	37.00 kgm.	37.00 kgm.
Average initial weight	7.30 "	7.30 "	7.30 "
Total final weight	321.60 "	401.10 "	364.60 "
Average final weight	80.40 "	80.22 "	72.92 "
Total weight of litter weaned			124.41 "
Total gains from fattening	284.60 "	364.10 "	327.60 "
Average gain per fattening pig	71.15 "	72.82 "	65.52 "
Average gain from litter of pigs per sow			24.88 "
Average daily gain per pig	.265 "	.231 "	.1515 "
Average daily gain per litter			.0589 "
Total grain consumed	1214.68 "	1590.07 "	2618.20 "
Average grain consumed per pig	303.67 "	318.01 "	523.64 "
Total cost of grain consumed	₱79.12	₱112.82	₱185.34
Average cost of grain per pig	₱19.78	₱22.56	₱37.068
Grain consumed per kgm. gain	4.268 "	4.369 "	5.792 "
Cost of grain to produce 1 kgm. gain	₱ .294	₱ .3070	₱ .412
Cost of grain to produce 100 kgm. gain	₱29.40	₱30.70	₱41.20
Selling value of pork at 60 centavos a kgm.	₱48.24	₱48.13	₱43.75
Selling value of litter per sow at ₱1.00 a kgm.			₱24.88
Total expenses feed, labor and other costs	₱39.04	₱38.15	₱58.40
Net profit per fattening pig	₱11.03	₱ 9.98	₱ 9.78

Table 6 gives the details of total cost of producing pork by lots including feed, labor, and other costs. This table is condensed to form table 7.

In table 7 the total feed cost is divided under three main items of cost; namely, feed cost, labor cost, and other costs expressed in terms of pesos, and percentage. The table is self-explanatory.

Bayan found that it cost ₱0.675 to produce one kgm. live weight of pork, while in this experiment the average cost for the three lots was ₱0.472.

Feliciano found that it cost ₱8.32 to raise each weanling pig; in this work the cost was ₱3.24.

TABLE 6

Cost of pork production by lots

	LOT I (SPAYED FEMALES)	LOT II (GILTS)	LOT III (SOW)
Number of pigs	4	5	5
Duration of experiment	308 days	322 days	422 days
Total cost of weanlings	₱29.20	₱36.50	₱36.50
Average cost of weanlings	7.30	7.30	7.30
Cost of raising gilts to breeding age			72.192
Average cost of raising gilts to breeding age			14.438
Cost of feeding gilts from breeding to farrowing			76.25
Average cost of feeding gilts from breeding to farrowing			15.25
Cost of feeding gilts from farrowing to finished condition			36.90
Average cost of feeding gilts from farrowing to finished condition			7.38
Cost of feed for total period	83.75	111.79	185.34
Average cost of feed per pig for the period	20.94	22.56	37.068
Total labor cost for 3 hours daily at ₱.10 an hour	20.25	23.62	33.10
Interest on average value of animals at 6 per cent[a]	4.50	5.5	8.34
Service fee[b]			10.00
Risk on loss of animals[c]	1.50	1.84	5.55
Interest, depreciation, and insurance on equipment	7.29	8.51	10.11
Cost of pastures and rent of land	1.76	2.25	2.30
Miscellaneous expenses	.60	.75	.75
Total expenses by lot	148.85	190.76	291.99
Average expenses per pig	37.21	38.16	58.40
Amount received for 19 weanling pigs weighing 124.41 kgm. sold at ₱1.00 a kgm.			124.41
Amount received for pork sold at ₱.60 a kgm.	192.96	240.66	218.76
Average returns per finished pig	48.24	48.13	43.31
Amount received for each litter			24.88
Total gross returns including weanlings	192.96	240.66	343.17
Total net profit	44.11	49.90	51.08
Average net profit	11.03	9.98	9.78

[a] Average value of animal = initial cost, plus total cost divided by 2.

[b] Five gilts were bred but only four of them produced litters.

[c] Two per cent insurance charge on lot I and II and 4 per cent for lot III.

SUMMARY AND CONCLUSIONS

1. By allowing female pigs to produce their first litters before they were fattened for the market it took 422 days to put them in market condition at a weight of 72 kgm. Spayed females not allowed to breed took 308 days to attain 80 kgm. in weight; and gilts not allowed to breed, 322 days.

2. To produce the 80.40 kgm. gain, lot I (spayed) incurred a total expense of ₱37.21; for 80.22 kgm. in lot II, (open gilts), the expense was

TABLE 7

Showing the distribution of the total cost of finishing pigs for market

	LOT I (SPAYED GILTS)		LOT II (OPEN GILTS)		LOT III (YOUNG SOWS)		AVERAGE	
	Cost	Percentage	Cost	Percentage	Cost	Percentage	Cost	Percentage
	pesos		*pesos*		*pesos*		*pesos*	
Feed cost	29.94	56.27	22.36	58.60	37.07	63.48	26.79	60.08
Labor cost	5.06	13.60	4.72	12.37	6.62	11.33	5.47	12.27
Other costs[a]	11.21	30.13	11.08	29.03	14.71	25.19	12.33	27.65
Total	37.21	100.00	38.16	100.00	58.40	100.00	44.59	100.00

[a] This item includes interest, depreciation and insurance on general equipment, land rents, cost of growing pasture crop, interest and risk on the average value of animals, purchase price of weanlings and miscellaneous expenses and service fee.

₱38.16; for lot III (sows) the expense of ₱58.40 for the combined gain of 97.07 kgm. was necessary.

3. Every 100 kgm. gain made by lot I, cost ₱46.28, lot II, ₱47.57, and lot III, ₱60.16.

4. Every 100 kgm. of the combined gains made by the sows and weanlings in lot III had a selling value of ₱70.25. The same amount of gains made by lots I and II had a selling value of ₱60.00.

5. The profit per 100 kgm. live weight by lot I, ₱13.72, lot II, ₱12.44, and lot III was ₱10.07.

6. Lot I consumed 283.06 kgm. of feed, lot II, 318.20 kgm., and lot III 523.84 kgm. to attain the finished condition.

7. Hog raisers have a choice of three methods of fattening females; as gilts, spayed females, or as yearling sows. In selecting the method, judgment should be based on influences exercised by the particular circumstances and conditions.

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A REVIEW: "POULTRY HUSBANDRY"[1]

A new book, *Poultry Husbandry*[2] has just been published. The book was prepared "to convey to its readers some conceptions of the background of the poultry industry, the fundamental principles involved in various poultry practices and up-to-date information concerning methods of poultry production."

Poultry Husbandry, although a technical treatise on the science and art of poultry production and marketing of poultry products is written so simply and arranged so admirably that even the layman can easily understand it. The author, Dr. Morley A. Jull, the Senior Poultry Husbandman of the Bureau of Animal Industry, United States Department of Agriculture, can have the satisfaction that comes when one has done a really big job. His book is truly an "encyclopedia of the poultry industry."

The book is divided into thirty-three chapters. With the premise that the "fundamental principles must be understood to some extent at least before the most economical methods can be practiced intelligently," the different topics covered in the chapters of the book are discussed, "first, in respect to principles involved and, second, in respect to practices to be followed." This plan makes the book useful not only to students of poultry husbandry, but also to farmers and commercial poultrymen.

The different chapters may be grouped roughly as follows: The first three chapters serve to introduce the general subject of the poultry industry to the reader. Judging and selection are taken up in chapters IV to VII. Breeding is covered in chapters VIII to XI. Three chapters, XII to XIV, cover the subject of incubation; the next four chapters take up brooding and its various aspects. Chapters XIX and XX are devoted to housing, and the fundamentals of nutrition, as well as feeding practices, are covered in chapters XXI to XXV. Chapter XXVI discusses diseases and parasites and their control. The various phases of marketing are discussed in chapters XXVII to XXXI, and the last two chapters are devoted to records and accounts and the laying out of poultry plants.

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[1] General contribution from the College of Agriculture No. 287.

[2] Jull, Morley A. 1930. Poultry husbandry. ix+639 p., 229 fig. New York: McGraw-Hill Book Company, Inc.

The extensive list of literature references appended aids in making this a book of great service to the poultry industry the world over. With an able review of the results of the various lines of research work referred to, the book also becomes useful to the investigator, to the teacher and to the student as well. This book will be welcomed by the great mass of poultrymen, commercial or otherwise, for not least among the merits of the book is the review of the results of poultry work in different countries. A poultryman has only to carefully read this book, the preparation of which "has been inspired in the spirit of rendering the greatest possible service to the poultry industry" to appreciate that it will fully give this service.

The numerous illustrations distributed all through the volume certainly aid in making it useful to all who may have the chance to use this book either as guide or as a reference.

F. M. Fronda
Of the Department of Animal Husbandry

EXCHANGE NOTES

The general public is little aware that during the last two years a new industry has developed in the Philippine Islands, and has given to the people, especially in the provinces, a new source of income. This is the manufacture of reptile skin products. . . . Skins are now collected and brought to Manila through regular marketing channels.

Enterprising men in the provinces with a little capital first read in the local newspapers about two years ago that skins of snakes and lizards are marketable. They inquired into the possibilities of this business, and when they were assured that any quantity of these skins would be bought,—and the more the better—they started propaganda in their localities and induced men who used to spend most of their time in the fields and woods, to trap these reptiles. . . .

They sold the skins to the middlemen, who in turn shipped them to the exporters in Manila. These middlemen now make weekly or semi-monthly shipments to Manila, ranging each from two hundred to two thousand pieces and more.

—*Commerce and Industry Journal* (Philippines.)

For generations ink has been a successful household remedy in the Philippines for the treatment of burns, Dr. C. A. Stammel, Captain, M. C. U. S. Army, has reported from Zamboanga, P. I., to the American Medical Association. The surprising thing is that a scientific basis for the treatment exists, although it has only just been revealed.

Most black inks are simply weak solutions of an iron and tannic acid compound, Dr. Stammel pointed out, and scientists have recently discovered that tannic acid itself is an efficient method of treating burns.

—*Science News Letter* (November 8, 1930.)

The quantity of sole rubber used by the Dutch shoe industry, increased from 75 tons in 1927 to 115 tons in 1928. Considering that in the year under review the total amount of crude rubber consumed by the Dutch rubber industry was 851 tons, it is obvious that in 1928 sole rubber contributed largely to the consumption of rubber in the Netherlands. The quantity used amounted to no less than 13.5 per cent of the quantity of crude rubber used by the rubber industry. . . .

Slipping on muddy streets still forms a serious disadvantage for the use of crepe soles. This drawback is, of course, felt in particular in towns, not in the country, sole crepe being therefore in several countries very popular in country districts. The Rubber Experimental Station at Buitenzorg has again tried to do away with the slipping difficulties, but has not been successful.

—*The Planter.*

The Department of Agriculture staged departmental exhibits of an educational nature at the Agricultural Shows held in July at Alor Star Seremban and Malacca. The Department is grateful to the respective Show Committees for the facilities given in this connection. The following particulars of the Departmental exhibit at Alor Star, Kedah, is typical of the participation of the Department at District Agricultural Shows this year. . . .

The display was arranged in sections as follows:—Selected strains of padi; rat destruction methods; copra and coconuts; tapioca, gaplek; pests of padi and coconuts; coconut diseases.

The padi and rice exhibits showed the advantages to be derived from planting selected seed suited to particular conditions, while the rat destruction section illustrated the best means of controlling rats by traps and poisoned baits.

The copra samples showed the common defects in the locally prepared product and explained how these could be avoided; while the coconuts in different stages of ripeness, namely ripe, underripe and overripe, indicated how the maximum amount of good copra could be obtained by picking only nuts that were fully ripe.

Tapioca roots were shown together with sliced and dried roots, known in commerce as "Gaplek". It was demonstrated that gaplek meal could be used, mixed with wheat flour, in the manufacture of bread, biscuits, scones and fancy cakes, samples of which were shown as prepared by the Central Bakery and Confectionery Co., Kuala Lumpur.

The entomological exhibits consisted of mounted specimens of the chief pests of padi and coconuts in different stages of development, whilst the section devoted to coconut diseases showed the damage done by a species of Marasmius on the leaf bases of the palm, and other exhibits the effect of lightning strike.

All the exhibits were suitably labelled in Jawi as well as in English, and a large number of instructive leaflets, also in Jawi, were distributed.

—*The Malayan Agricultural Journal.*

"Cleanliness is next to Godliness," so we hear. The chap who invented that phrase must have been a poultryman and probably referred to brooding chicks. Of all the times where cleanliness is important it is during the first ten weeks of a chick's life. Where else do we have livestock, as poultry is now officially known, concentrated in so small a space as we keep chicks?

The more crowded the chicks, the more strenuous must be the elbow grease and care that result in cleanliness.

Cleanliness means frequent changing of litter, frequent scraping of the floor where droppings have stuck, and a good disinfection and scrubbing before each new batch of chicks comes in. If dirt yards are used, they should be swept regularly with a stable broom, or scraped if the ground is too soft to sweep.

Cleanliness means supplying feed in troughs that are so constructed that one chick does not get droppings into that feed for the next chick to eat.

Cleanliness means the thorough scrubbing of water fountains daily.

Yes, truly, cleanliness is next to Godliness, in the poultry game.—*R. W. G.*

—*California Cultivator.*

COLLEGE AND ALUMNI NOTES

On the evening of December 13, the Siamese Students' Association gave a reception and dinner at the Manila Hotel in honor of H. R. H. Prince Purachatra who was in the Philippines studying industrial and commercial conditions. Prince Purachatra, a brother of the King of Siam, is Minister of Transportation and Communication in Siam. Among the guests were Dean and Mrs. San Agustin, Doctor and Mrs. Robert L. Pendleton, Professor and Mrs. Manuel A. Roa, Professors Emma S. Yule and Anne F. Cole, and Doctor and Mrs. Miguel Manresa and Doctor and Mrs. A. Gordon, from the Los Baños Colleges.

Doctors Valente Villegas, Leon Gonzalez, Mariano Mondoñedo, and Miguel Manresa from the College of Agriculture, and Dean San Agustin, Doctors Angel Gomez, Zacarias de Jesus, Ramon Javier, José Uichanco and Anacleto Coronel from the College of Veterinary Science and Dr. Sixto Francisco, College Physician and Mr. Alfredo Yñiguez, Chief Clerk, visited the Manila Jockey Club on Sunday, December 7, 1930 as guests of Messrs. Rafael and Marcos Roces. A very delightful luncheon was served by the hosts. Secretary Alunan of the Department of Agriculture and Natural Resources was also a luncheon guest. The object of the visit was to study the different types of horses used in the races.

The Los Baños Biological Club met on the evening of November 20, 1930, in the Lecture Hall of the Department of Agricultural Chemistry.

The following papers were read and discussed:

1. "Experiments on the treatment of sugar cane points with insecticides and insect repellants" By Dr. L. B. Uichanco and Mr. C. T. Buligan.
   Read by Doctor Uichanco.
2. "Influence of light upon growth and development of certain plants" By Dr. R. B. Espino and Mr. F. T. Pantaleon.
   Read by Doctor Espino.

The Class of '32 was host at a very delightful Junior-Prom on the evening of November 29, 1930. Besides the honor guests, the Seniors, several members of the faculty were present. The open paved space between the Seed House and the Tool House under the skillful hands of the Juniors had been converted with bunting, palms, banners and strings of shaded lights into a charming dance pavilion. The soft light from "The Lovers' Lamp" added to the beauty and the pleasure of the first Junior-Prom given in the College of Agriculture. May it become an annual affair to be anticipated by the Seniors!

The A. W. S. (Associated Women Students of Los Baños Colleges) presented a dramatization of "Courtship of Miles Standish" on the evening of November 15, 1930.

As this was the first program given by this club the evening was anticipated with interest, and no one was disappointed.

The scenes were arranged and directed by Mrs. F. L. Stevens. The members of the A. W. S. are fortunate in having the advantage of being trained by one who has had Mrs. Stevens' wide experience in presentation of drama.

The reading by Dr. F. L. Stevens, Baker Memorial Professor 1930-31, of the parts of the poem not included in the scenes presented added greatly to the enjoyment of this well-loved romance of the Puritan colony.

The program follows:

Miles Standish	Mamerta Manahan
John Alden	Felipa Belo
Priscilla	Purificacion Caguicla
Indian	Arturo Villa Ignacio
Clergyman	Felicidad Chan
Wedding Guests	Victoria Mendiola Elena Caguicla Máxima Mulimbayan Iluminada Torres Teófila Aquino Leonisa Villegas Luz Ang Emilia Odejar Leonor Pandingco Pilar Elayda Aurelia Capinpin

SCENE 1

Scene: A room in Miles Standish's cabin.
Time: Afternoon.

SCENE 2

Scene: A room in Priscilla's home.
Time: Later.

SCENE 3

Scene: Same as 1.
Time: One hour later than Scene 2.

SCENE 4

Scene: Same as 2.
Time: A few weeks later.

II

READINGS

The readings from the poem will serve as an introduction to the play and they will carry on the story between scenes.

III

MUSICAL NUMBERS

Before Scene 1

Song: Sailor Song by College Quartette	Felino Manzano Raul Arana Praxedio Golez Pedro Lorenzo

Between Scenes 1 and 2

Song: The Spinning Maiden by College Quartette.

Between Scenes 3 and 4

Squaw dance	Women of A. W. S.

The squaw dance—an "extra touch"—was colorful, and the dance by the "brave" Arturo Villa Ignacio carried a thrill.

With the exception of the "brave", the men's parts were played by women. The praise heaped upon them was merited.

The advisor, Miss Katherine Turner, and A. W. S. are to be congratulated on their first program.

THE WHIRLIGIG OF TIME[1]

This number of THE PHILIPPINE AGRICULTURIST closes the volume for the College year 1930-31. When the old year stamps "last day" on its volume one often becomes musingly reflective, so the closing of volume XIX of this journal brings on a reminiscent mood. One thinks of former colleagues, those other builders of the early and of the more recent days, and memory calls them up one by one as vital members of the College Community, and fancy tries to picture them as they have carried on since they waved us a last *adios*.

There is Dr. E. B. Copeland, the Founder and first Dean of the College. Records show that he retired in 1917 to his farm near Chico, California. But men of Dean Copeland's mental and physical structure do not retire *de facto*. The College Founder is a combination of Cincinnatus and Horace and a few other notables who followed the back to the farm urge. He has produced books in his study, notably the highly praised volume bearing the title *Rice*. This book is not exactly an Horatian Ode, but it will suffice to show the Doctor's literary trend. And his Cincinnatus propensities have found an outlet in adding to the world's supply of food from his extensive rice farm near Chico. In many other ways our First Dean uses his ability. He was never a low-power engine.

Our second Dean, Charles Fuller Baker, after ten years of superb service, on July 22, 1927 slipped behind that curtain that never swings back. A short time before Dean Baker left us the Board of Regents had made him Emeritus Dean of College of Agriculture and Professor of Tropical Agriculture and Director of U. P. Experiment Station, to be effective at the end of the year when his resignation, already accepted by the Board, was to go into effect. The Dean's memory is perpetuated in the College by the Baker Memorial Professorship and the Baker Memorial Scholarship for a senior self-supporting student. The scientific world benefits by his Malayan Entomological Collection which he willed to the Smithsonian Institute in Washington, D. C. With students and faculty who were so fortunate as to be associated with Dean Baker there are ever fresh flowers before his shrine in each heart.

Richard Morris Holman was one of Dean Copeland's band of hustlers from 1910 to 1912. Those were the days when the first slashes were being made in the "carving of this college out of a jungle". Professor Holman was primarily High Priest in the botany laboratory, but on request he took over, in addition, the chemistry work,—not the laboratory, for the equipment was probably one test tube and possibly a spirit lamp. Today, Holman occupies a chair in the botany department in University of California.

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[1] General contribution from College of Agriculture No. 285.

M. Manas Cruz was another of the hardy pioneers. On his return from the United States where was graduated from Ohio State College, he was appointed in 1910 one of the first instructors in agronomy. He was the first farm superintendent in the College. In 1912, Mr. Cruz resigned to accept a position with the Bureau of Agriculture. In the reorganization of this Bureau in 1929 Mr. Cruz remained with the Bureau of Plant Industry.

Samuel B. Durham, one of the first staff in the tent and one-building days, tarried with us only about two years, but he did work that is still cited in animal husbandry. As he went from the Islands to Texas, he is probably a Cattle King now.

Edgar M. Ledyard, was assistant professor of entomology from 1911 to 1914; and also teacher of engineering and helper in a few other jobs. In the good old pioneer days no one occupied a chair, each held down a bench. Mr. Ledyard since he returned to the homeland has stayed put with the United States Smelting Refining and Mining Company at Salt Lake City, Utah. He is now director of the company.

Mrs. Ledyard was the first and the sole instructor in English in the College. We like to think that the Ledyards use gentle, wistful adjectives when they speak of their days on the pioneer campus at the base of Mount Maquiling.

Albert G. Glodt was instructor in physics and agricultural engineering from 1912 to 1914. His extra-curricular work was superintending the completion of the College water system, the installation of the electric plant, and the construction of a laboratory and some minor buildings. Mr. Glodt had been an officer of engineers in the French army. In the late summer of 1914 he was called to join the colors. What his part or what his fate in the Great War, his former colleagues in the College do not know.

Dr. F. C. Gates, professor of plant physiology from 1912 to 1915, has stuck by his job of studying and teaching the workings of the oft-times puzzling plant. But he went back to the less luxuriant flora of the Middle West of the United States. He is now head of the plant physiology department in Kansas Agricultural College.

The chemist, Dr. Horace G. Deming, since leaving the College in 1916, after a few years' service, has held the position of professor of chemistry in the University of Nebraska and acquired fame and we trust a little lucre through a text book, *General Chemistry*.

Harold Cuzner was in the College from 1912-21. He was in agronomy at first, then head of the engineering department. He just moved up the hill when he left us to become professor of silviculture and "In charge" of the School of Forestry.

Joseph Cocannouer after three years in the agronomy department went in 1918 to Chowchilla, California, where he holds some sort of a dual job of teaching and of advising a company of some kind as to the best way to grow crops. Cocannouer was the first one to demonstrate that clove pinks would grow well on Faculty Hill. This was not, however, the greatest of his achievements while with us.

F. W. Ashton who was with the chemistry department from 1915 to 1921 went direct from this land to the Bureau of Standards, Washington, D. C., where he still is. "Freddie" needs no inoculation against wanderlust.

Charles S. Banks after five years as head of the entomology department retired to Manila. He gave much time at first to the city's campaign against mosquitoes. Of late years he indulges in philately and other interests. He was ever tinted with dilettantism. A book for children about insects is his recent contribution to humanity's needs.

Dr. Forman T. McLean was head of the plant physiology department from 1917 to 1921. After returning to the homeland he was for some time with the Rhode Island Experiment Station. Some three years ago he accepted a position with an experiment station connected with Columbia University. "Mac" would rejoice could he see the flaming gladioli on Faculty Hill, for he was quite "Ritzy" when he first demonstrated they could be grown here. The raspberries, however, which he started on Mount Maquiling would not puff him with pride for they are poor tasteless things.

Dr. Sam F. Trelease, one time editor of THE PHILIPPINE AGRICULTURIST and associated three years with McLean in plant physiology was tempted by an offer from his former major professor, Dr. B. M. Livingston in Johns Hopkins, so said *adios* in 1920. Two years later he accepted the position as head of the botany department in the University at Louisville, Kentucky. After two years he hopped up a few rungs and lighted in the botany department in Columbia University. "Doctor Sam" is no climber, but how he can plug. As he was rapidly hopping up the rungs of life's ladder, he published several articles, edited each year the mammoth program for the American Society for Advancement of Science, and as the students and faculty in the College know, collaborated in that handy little aid, *The Preparation of Scientific and Technical Papers.* This past year, "Doctor Sam" and his wife, to celebrate his promotion to the position of executive head of the department of botany in Columbia University, with the ever welcome additional stipend, traveled for three months in Europe winding up with attending the International Botany Congress in Cambridge, England.

Dr. Otto A. Reinking, started the plant pathology department in 1916 and worked it up to peace strength, sandwiching in trips to China and Siam where he sought for the secret scandals in the past of the citrus family; these he shamelessly revealed as well as some facts about the present generation. In 1922 "Otto" left us for the United States and joined The United Fruit

Company, which gave him greater opportunity for roaming. He has twice returned to the Islands seeking for obscure members of the banana family. So keen on the chase was he that his search took him to the interior of New Guinea where men of his blonde type had never been before. "Otto" was ever intrepid. His Christmas greetings for 1931 were sent from Honduras.

For two years Jacob J. Wodraska, labored to give our students a more facile tongue in English and to add to their familiarity with the Castilian speech. But in 1921 the call of Greater New York, his birthplace, was stronger than the Call of the East. But "Wodie" has stuck to his calling. He is now owner and Head Master of his own school in Paterson, New Jersey.

Harold E. Woodworth, held sway in the entomology department from 1920 to 1923. Returning to the homeland Lady Luck led him to the lucrative job of entomologist for a large oil company in Bakersfield, California. Lady Luck stood by and so manipulated the shooting of the arrows of the little plump chap with wings that "Harold the Tall" led the daughter of the president of the company to the altar. Lady Luck can be a good pal.

Following Doctor Reinking, Colin A. Welles, held the fort in plant pathology for about two years. Illness sent him back to Milwaukee where he is teaching in a high school and rumor says running a fox farm on the side. Mrs. Welles, who was instructor in history, teaches in a Milwaukee high school, does some newspaper work, and in between times has managed to take a law course. In odd moments she advises about the fox farm. "Doris" was ever versatile, and inclined to be volatile.

Francisco Quisumbing, one of our graduates, returned to us in 1921, with his title of "Doctor" acquired in Columbia University. But Manila looked very good to him. So he was transferred to College of Liberal Arts, department of chemistry, in 1922. Francisco has a flair for industrial chemistry. "Quisumbing Ink" has been on the market and on our desks for some years. Through marriage he is allied with one of the large mercantile firms in the capital. In this business he is more than a silent partner.

Mrs. J. R. Gillis was in the English department from 1915 to 1920. With Mr. Gillis, forester and lumberman, Mrs. Gillis went from our campus to Zamboanga. Last year she returned to Manila where she is teaching in the Union High School. Mrs. Gillis has the distinction of "putting on" the first dramatic work on the Campus. In 1915 she "presented" the Court Scene from *Merchant of Venice*. With the proceeds she bought the first non-scientific books in our library.

Frank P. McWhorter, was a useful man. He came to us in 1921 as associate professor in plant physiology. When the necessity arose he was transferred to plant pathology as head. In 1923 he returned to United States where he was plant pathologist in the Virginia Truck Experiment Station at Norfolk, Virginia, until 1930. Doctor McWhorter is now head of the department of plant pathology in College of Agriculture at Corvallis, Oregon, and special plant pathologist on ornamentals for the United States department of agriculture in Oregon. "Mac" is just as enthusiastic as ever in photographic performances. He has done some fine work in photographing diseased bulbs. He still dissects cameras with all his old eagerness.

Hazel Kenward who was in the department of chemistry from 1919 to 1923 returned to the Campus in 1925 and became the wife of Otto Pflueger of the School of Forestry. In 1929, the Pfleugers returned to the homeland. Mr. Pflueger is a member of faculty of the Mount Alto Forestry School, Mount Alto, Pennsylvania.

Evett D. Hester came to the College as professor of rural economics in 1919. This was a new subject in the College so his job was waiting this quiet young man. And he rose mightily to that job and several others in the next six years. Soon it was known that there was a department of rural economics offering all the courses that could be wedged in, and doing all the investigating possible. When "Doctor Sam" left us, Mr. Hester was made editor of THE PHILIPPINE AGRICULTURIST. Ere long Dean Baker appointed him Registrar. Mr. Hester has a large bump of organization always "on the mark" ready for a sprint. Soon the Registrar's office was organized, and running on gears kept well oiled by the boss's close attention. As Chairman of the Library Committee Mr. Hester organized our Library; installed the Congressional Library card system; trained the first Librarian; planned and superintended the remodeling of the Library rooms; installed the stacks; secured and hung pictures; in short, gave us a Library. Digging around in statistics and such stuff is an agreeable little outing for Mr. Hester. So when Dean Baker wished data well prepared and comparative relations presented to support some project, he usually cordially invited Hester to take one of these delectable outings. After putting in six full years Mr. Hester left us in 1925 amid lamentations and good wishes. The next year found Mr. Hester Commercial Attaché of the American Embassy at Madrid. Two years later he was in charge of the branch office in Barcelona. Great was the rejoicing of the faculty and older students of this College when in April, 1930, Mr. Hester returned to Manila as United States Trade Commissioner. That the afternoon of the day of his arrival saw him on the Campus told more convincingly than words his devotion to the institution to which he had given his best in energy, industry, and ability.

Desmond A. Herbert hailed from Australia. From 1922 to 1925 he was head of the department of plant physiology. Also as a side job, was editor of THE PHILIPPINE AGRICULTURIST, succeeding Mr. Hester. Plant life to "Herb" was his life. He would lope up Mount Maquiling as an early morning jaunt—just to see what he could see and there was little that he did not see—not a knoll, not a gulley that he had not poked around in. Few were the plants with which he did not get on speaking terms. But the call of home was stronger than the lure of Maquiling flora. He accepted the position as head of department of biology in University of Queensland, Brisbane. Here he has stayed, and during his stay has picked up a Ph. D.

In 1923, E. Gertrude Madison came to us as assistant professor in English. Her father's illness prevented her staying longer than to 1925. But what a service she gave in those two years! Not only in the class room but in many ways and in many lines. As one student said the year after she left, "Miss Madison brought much joy to the Campus". Under her able willing hand the College Sing was started; and dramatics was initiated. Seldom was she absent from any athletic or sport event. Her splendid ability in the class room and on the campus has been the possession of Waynesburg College, Waynesburg, Pennsylvania since 1925.

J. Edgar Higgins, came to the College in 1921 as head of department of agronomy. Professor Higgins' special line was pomology. Perhaps his most lasting service was the promulgation of the usefulness of the avocado, "poor man's butter", the improvement of the papaya and the pineapple. Mrs. Higgins' illness in 1925 made their return to the United States imperative. Their leaving was much regretted. As Dean Baker said: "Kindly and well-meaning Christian people of the type of Professor and Mrs. Higgins are an ornament to any College staff and their influence is greatly to the benefit of all". Since 1926 Professor Higgins has been Chief Agronomist in the Canal Zone.

José P. Mirasol, one of our graduates, after receiving his doctor's degree from the University of Illinois returned to us in 1921 as one of the chemistry staff, specializing in soils chemistry. In 1926, he became the second dean of the newly established Junior College of the U. P. at Cebu. After two years he turned his back upon the teaching profession for the job of consulting chemist with planters at the Sugar Central at Manapla, Occidental Negros.

Dr. Manuel A. Roxas, the first graduate of the College to be appointed on the faculty, joined the chemistry staff in 1916 when he returned from the United States, where he received a doctor's degree from the University of Wisconsin. Later, he was head of the department. Appreciating that no crop in the Islands was crying so lustily for specially trained men as was sugar, Doctor Roxas planned and had incorporated in the curriculum the sugar technology course. Overcoming many obstacles, he established the U. P. Sugar Mill. He formed alliances with some sugar centrals which secured broader and more practical training for the sugar students than they could obtain in the College. In the last years of his connection with the College he was with the Philippine Sugar Association a part of each year. In 1927, Doctor Roxas resigned to accept a position as experimental agronomist with this association. In 1929, when the Bureau of Plant Industry was organized he was appointed director. Doctor Roxas is Professor Emeritus, of Chemistry, the second professor of the College to be so honored.

Toribio Vibar, also one of our graduates, on his return from the United States in 1921 as "Doctor" was appointed in the agronomy department in charge of farm crops division. In 1928, Doctor Vibar resigned to accept a position with the Bureau of Education as Supervisor of Farm Schools. In 1930, he was appointed agronomist in the Bureau of Plant Industry.

Mariano B. Raymundo, one of the pioneer students of the College, a graduate from the College of Agriculture, University of Wisconsin, was on the agronomy staff as farm superintendent from 1922 to 1928. Raymundo found time in between completing his work in the University of Wisconsin and joining the agronomy staff in this College to grow rice on Copeland's farm near Chico, California, to the increase of his worldly gear. Mr. Raymundo has a practical mind and an eye for the intricacies of the anatomy of farm machinery. This led him while farm superintendent to make changes that adjusted imported farm machines to the Philippine conditions. In 1928, Mr. Raymundo resigned that he might give his time to looking after personal farm and irrigation properties in Pila, Laguna, and Morong, Rizal.

Margaret Wilson, assistant professor in English, arrived in 1925. She soon made herself felt as a personality on the Campus. Dramatics was pushed and the Mimics organized and several plays were well presented. There was much lamenting when Miss Wilson said good-bye in 1928. And of the tears that flowed many trickled from Margaret's eyes. After completing work in 1930 for Master's degree in her Alma Mater, University of Wisconsin, she again returned to teaching. She is now head of the department of English in the Hanover College, Hanover, Indiana.

Eduardo Quisumbing, another of our graduates, returned from the United States after acquiring a Doctor's degree and was appointed on the staff of plant physiology department. Through Dean E. D. Merrill of College of Agriculture, University of California (formerly director of Bureau of Science, Manila), Eduardo was appointed in 1926 to a fellowship from the National Research Council in Washington, D. C., to work on the flora of the Philippines with Dean Merrill in Berkeley, California. Doctor Quisumbing returned to the Islands in 1929 and was transferred from the College to the botany division in the Philippine Bureau of Science.

Mariano Lopez, successor to Professor Hester as head of rural economics department and registrar, resigned after four years service and is now with Bureau of Banking, Manila.

Vicente Aldaba, one of our graduates, after receiving a doctor's degree in the United States returned to the College in 1926. He was appointed in charge of fiber division in the agronomy department. In 1929, he resigned to accept a similar position in the Philippine Bureau of Science.

Cecilio Alincastre, sugar chemist, was with us from 1925 to 1928. He is now Planters' Chemist, at Maao, Occidental Negros.

Elias Pañganiban, one of our graduates, after he returned from the United States with a doctor's degree was on the chemistry staff for three years. He resigned in 1927 to take up the job of managing his father-in-law's hacienda in Fabrica, Occidental Negros.

C. P. Johnson was for three years head of department of engineering. Professor Johnson who can construct any farm tool or machine from a garden rake to a serviceable automobile out of a pile of junk is now teaching this same skill along with practical agriculture to boys in a high school near San Francisco.

Names once daily heard and faces once daily seen on the Campus come crowding. Some when they waved farewell, gave us a final flip, of others rumors come and from some letters. Among the last group, of those who were in the department of English is Ruth Taylor, teaching in Tennessee, Dorothy Hall, now Mrs. Brewer, resident of Hongkong, Marcia Whipple, now helpmate of Lieutenant Shingle stationed at Ft. McClellan, Alabama, Thomas O'Leary, pedagogue in Cuba, Esther Anderson teaching in high school, Los Angeles.

There is Irving Leonard who was head of agricultural engineering for a short time, when the illness of Mrs. Leonard compelled their return to a older climate. Later, he received a doctor's degree from University of California, majoring in Spanish. Wrote two books on a Mexican savant, that with other research made impression so forceful that he was offered a fellowship in 1930 for a year's study abroad from the American Council of Learned Societies of Washington, D. C., supported by the Rockefeller Foundation. Naturally, Doctor Leonard went to Spain for study.

Dean Gonzalez, in commenting on our ex-members of faculty once said: "I feel that we have faculty alumni as well as student alumni. And the College has in this faculty alumni a very keen interest and feels a justifiable pride in the success of each one". And in truth the innocuous members of this faculty alumni are so few as to be negligible. With Roosevelt they would seem to believe that "The life worth living is worth working for". Consequently, we have no apologies to make for our "faculty alumni"; we think and speak of them with pride and rejoice in their success. And those who worked in the College and for the College memory limns in clear and faithful lines. With us they are not "Snows of Yester-year".

EMMA S. YULE,
Of the Department of English.

THE NUTRITIVE VALUE OF BALUT: I STUDIES ON CALCIUM[1]

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With the collaboration of Mr. Pedro Paje of the Department of Animal Husbandry

INTRODUCTION

Balut is the Filipino term for egg that is partly incubated and then boiled hard. Of the different kinds of eggs, the duck egg is the only one made into *balut* on a commercial scale. A *balut* costs much more than a fresh egg. It is a favorite food of the people in Central Luzon; and the people in the Visayan Islands are fast learning to like it. A woman from Central Luzon has made a fortune selling *balut* in Cebu. The people of the Malay Penninsula are also fond of *balut* (Fronda, 1925-26). Because of its extensive use and the high price it commands, a knowledge of the nutritive value of *balut* seems desirable.

Review of literature

Two kinds of *balut* are sold in the market—*balut mamatong* and *balut sa puti*. *Balut mamatong* is prepared by incubating the egg for about fourteen days, and *balut sa puti* by incubating it seventeen or eighteen days. The most noticeable difference between a fresh egg and *balut* is the presence of an embryo duckling in the latter. The edible portion in *balut* may be divided into: liquid, yolk, albumen, and embryo duckling. By some, *balut* is considered a well balanced food as it has broth, meat, etc.

Balut sa puti is very delicious and is preferred by persons who can eat the large embryo. Those who do not like the large embryo usually prefer the *balut mamatong*. It is not unusual to find people who choose the *balut sa puti* but discard the embryo. How delicious a *balut* is, is known only to those fortunate enough to have actually eaten it.

The high food value of eggs is generally recognized. As to whether it is economy to pay more for *balut* than for ordinary fresh eggs remains to be proved.

Fronda and Dañgilan (unpublished study) found an increase in the ash of the edible portion of the egg during incubation.

E. Carpiaux (1908) found that the calcium of the edible portion of the chicken egg increases as the embryo develops; and that the shell furnishes more than 80 per cent of the necessary calcium. Gangl and Hammerschlag (1908) found that the shell of an egg loses 0.15 gram of calcium during incubation.

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No determination of calcium in the different parts of the edible portion in *balut* has been found in available literature.

In eating either kind of *balut* the liquid and yolk are always consumed. In addition to these parts, a considerable number eat also the albumen and the embryo. Because of this difference in the way people eat *balut*, it would seem to be of interest and value to determine the calcium contents of the different parts of the edible portions.

The importance of calcium in nutrition can not be over-estimated. About 85 per cent of the mineral matter of bone or at least three-fourths of the entire ash of the body consist of calcium phosphates (Sherman, 1919). Calcium salts are necessary for the coagulation of the blood and its presence in a small quantity is absolutely necessary to the normal action of the heart muscle. Calcium neutralizes any abnormal effect which may be produced by sodium, potassium or magnesium, whether of decreased or increased irritability (Meltzer, cited by Sherman 1919).

Lusk (1928) emphasized the importance of a diet rich in calcium for pregnant women, especially during the last two weeks of pregnancy, when the fetus is storing calcium at a rapid rate. According to Aron and Sebauer (1908) the ill effects of calcium deficiency are confined exclusively to the skeletal system and produce a condition resembling rickets. Deficiency in calcium causes the formation of bones with an excess of water and with organic material insufficiently calcified. Sherman (1919) attributed the abnormal weakness and flexibility of the bones of puppies to lack of calcium in the diet.

The weakening of the bones and teeth, a common accompaniment of pregnancy and lactation is largely due to the withdrawal of calcium from these structures to meet the nutritive requirements of the embryo (Bunge, cited by Sherman 1919).

The minimum amount of calcium required by a person for normal nutrition is not known. There is no definite standard of calcium requirements for different classes of people. Lusk (1928) stated that Bertram found that 0.4 gram of calcium oxide is sufficient to maintain calcium equilibrium and that Herxheimer obtained the same result with a man who took 0.86 gram of calcium oxide. Hereman (Lusk 1928) places the calcium requirement at 1.7 gram calcium oxide. Sherman, Gillet, and Pope (1919) obtained from two subjects 0.49 and 0.38 gram of calcium as requirements per man per day calculated on a basis of 70 kilograms of body weight. German authorities (Lusk, 1928) state that a man requires about 1.5 gram of calcium oxide. Sherman (1919) believes that 0.63 gram of calcium oxide per 70 kilograms of body weight per day represents the average maintenance requirement for normal human nutrition.

The Filipinos investigated by Roxas and Collado (1922) were found to have an average calcium oxide intake of from 0.11 to 0.15 gram a day. This amount is very low when compared with the intake of other people.

Since the Filipinos' intake of calcium is probably low, any food material that may give aditional calcium is beneficial.

Object

It was the object of this investigation to determine the amount of calcium in the different parts of the *balut*.

MATERIALS AND METHODS

One hundred fresh duck eggs were purchased in the barrio of Mayondon, Los Baños, Laguna, August 28, 1929. Fifteen of these eggs were boiled hard and the rest were incubated.

The shell and the edible portion of the hard boiled eggs were weighed separately. Then these weighed materials were dried to constant weight in an electric oven at 100°C. degrees.

On September 11 (14 days later) twelve fertile eggs were taken from the incubator and boiled hard. These eggs were analyzed as *balut mamatong*. The shell, yolk and liquid, embryo and albumen were separated, weighed, and dried in the oven. Then the weights of the dried materials were determined.

On September 14, (17 days later) another twelve fertile eggs were boiled hard and analyzed as *balut sa puti*, following same process as with *balut mamatong*. The rest of the eggs in the incubator were bagged and allowed to hatch.

On September 25, six eggs hatched. The ducklings were chloroformed and the feathers removed. The shell, feathers, and ducklings were dried and weighed as the *balut* had been.

Before analyzing the samples for calcium, the oil of the edible portion of the fresh eggs and the yolk and liquid of the two kinds of *balut* was extracted with ether. After the oil was extracted from these portions, they were dried in the oven.

All of these dried materials were ignited in a Bunsen flame and then ashed in an electric furnace.

The ash of the edible portion was dissolved in 6N hydrochloric acid solution and used as a whole for the analysis. In the shell, the ash was dissolved with 6N hydrochloric acid solution and diluted to 500 cc. Then two aliquot portions of 25 cc. each were taken for analysis. Calcium was determined according to the *Methods of Analysis of the Association of Official Agricultural Chemists.* (1924).

RESULTS

The results of the analyses are shown in table 1.

TABLE 1

Calcium oxide content of duck eggs

SAMPLES	1	2	3	4	5	6	7	8	9	10	11	12	AVERAGE
	grams	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*
Fresh egg													
Shell	3.6482	3.6774	3.7260	4.0176	3.9690	4.0014	3.7746	3.8718	3.7260	3.6450	3.8556		3.8102
Edible portion	.0486	.0437	.0470	.0486	.0486	.0460	.0444	.0447	.0415	.0415	.0447		.0454
Balut mamatong													
Shell	3.6612	3.9204	3.5802	3.9042	3.9042	3.6288	3.5964	3.5154	3.9042	3.9042	3.7422	3.5640	3.7354
Yolk and liquid	.0431	.0392	.0421	.0421	.0428	.0408	.0399	.0411	.0392	.0389	.0382	.0373	.0404
Albumen	.0065	.0065	.0058	.0068	.0065	.0068	.0065	.0062	.0068	.0068	.0065	.0068	.0065
Embryo	.0013	.0016	.0013	.0013	.0013	.0013	.0013	.0016	.0013	.0013	.0013	.0010	.0013
Edible portion	.0509	.0473	.0495	.0502	.0506	.0489	.0477	.0489	.0473	.0470	.0460	.0451	.0482
Balut sa puti													
Shell	3.7260	3.6126	3.4506	3.5802	3.7260	3.7260	3.2886	3.7260	3.7422	3.7260	3.4992	3.4668	3.6058
Yolk and liquid	.0363	.0369	.0382	.0373	.0337	.0324	.0382	.0327	.0382	.0321	.0308	.0330	.0349
Albumen	.0032	.0039	.0039	.0042	.0042	.0042	.0039	.0042	.0045	.0049	.0039	.0045	.0041
Embryo	.0129	.0130	.0133	.0130	.0165	.0139	.0136	.0149	.0143	.0130	.0168	.0126	.0139
Edible portion	.0524	.0538	.0554	.0545	.0544	.0505	.0557	.0518	.0570	.0500	.0515	.0501	.0530
Hatched egg													
Shell	3.8070	3.4506	3.8394	3.4506	3.6774	3.4182							3.6072
Duckling	.1095	.1102	.1105	.0962	.0926	.0590							.0963
Hair	.0005	.0004	.0004	.0003	.0003	.0004							.0004

DISCUSSION OF RESULTS

The calcium oxide contents of fresh shell (table 1) varied from 3.6482 to 4.0176 grams with an average of 3.8102 grams. In the shell of *balut mamatong* the calcium oxide content ranged from 3.5154 to 3.9204 grams with an average of 3.7354 grams. The calcium oxide in the shell of *balut sa puti* varied from 3.2886 to 3.7422 grams with an average of 3.6058 grams. From the fresh shell calcium content, to that of the shell of *balut mamatong* there was a decrease of 1.96 per cent, to that of *balut sa puti* 5.38 per cent. From these results it is evident that the calcium oxide of the shell decreases as incubation proceeds.

The edible part of the egg contains an appreciable amount of calcium oxide. Although this amount is very meager as compared with that of the shell, yet it is valuable in considering nutrition because it is the calcium that may be made available for the body's need.

The amount of calcium oxide in the edible portion of the fresh egg varied from 0.0415 to 0.0486 gram and gave an average of 0.0454 gram. In the *balut mamatong* the yolk and liquid contained a much greater calcium oxide content than that of either the albumen or the embryo; the average being 0.0404 gram for the yolk and liquid and 0.0065 for the albumen and 0.0013 gram for the embryo. The amount in the edible portion (yolk and liquid, plus albumen, plus embryo) ranged from 0.0451 to 0.0509 gram and gave an average of 0.0482 gram. From these results, it is seen that the average calcium oxide of the edible portion of *balut mamatong* is greater than that of the fresh egg by 6.18 per cent.

The table shows that the calcium oxide content of the yolk and liquid of *balut sa puti* is generally less than that of the yolk and liquid of *balut mamatong*. The yolk and liquid of *balut sa puti* gave an average of 0.0349 gram or 13.61 per cent less than *balut mamatong*. The same relation exists in the case of the albumen; the average amount of calcium oxide being .0041 gram for *balut sa puti* or 36.92 per cent less than in *balut mamatong*. In the case of the embryo, the opposite relation exists. The calcium oxide content, 0.0139 gram, of the embryo of *balut sa puti* is almost ten times as much as the content .0013 gram of *balut mamatong* or an increase of 969.23 per cent. The duckling gave an average of 0.0963 gram calcium oxide. The calcium of the edible portion of *balut sa puti* was 16.78 per cent more than that of the fresh egg. From these results it is seen that the longer the incubation of the eggs for *balut* purposes, the greater will be the amount of calcium oxides in the edible portion, and that, as the embryo increases in size, its calcium content is proportionally increased, while it decreased in the yolk and liquid and albumen.

CONCLUSIONS

1. The calcium content of the fresh egg, of the *balut*, and of the hatched eggs is given.

2. As incubation proceeds, the calcium content of the shell, yolk and liquid, and albumen decreased, while that of the embryo duckling increased.

3. In *balut sa puti*, if the embryo duckling is discarded, the edible portion contains less calcium than the edible portions of the fresh egg. Hence, the necessity for eating the embryo, if calcium is desired.

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SOME TREE-DESTROYERS BELONGING TO THE MISTLETOE FAMILY (LORANTHACEAE)[1]

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WITH THREE TEXT FIGURES

As a ranger of the Bureau of Forestry, the writer has travelled extensively not only in the provinces of Laguna and Batangas, but also in Tayabas, Camarines, and Cotabato, Mindanao. On several occasions, his attention has been directed to dying fruit trees, especially lansones and citrus, in Laguna, Batangas, and Tayabas. Upon careful examination he found that the cause of death was plant parasites on the stems, branches, and twigs of the trees. Few people know these parasites or have any idea how they attack and kill their lansones and citrus trees as well as forest trees. It is the object of this paper to describe these tree-destroyers and the harm they do, so effort may be made to eliminate them.

The affected trees can be recognized easily by there being on the stems and branches swollen nodes from which grow shrub-like plants very different in appearance from the tree on which they are found. Other symptoms are the stunting and dwarfing of the twigs and foliage and also the death of the terminal parts of the branches, depending upon the severity of the infection.

BOTANICAL DESCRIPTION AND DISTRIBUTION

Family

The plant parasites referred to above belong to the family Loranthaceae. The members of this family are parasites or semi-parasites with green leaves. They attach themselves to their hosts by means of root-like suckers, or haustoria. In the Philippines, the Loranthaceae are represented by eight genera and one hundred and two species, including one variety. They are found from sea level up to an altitude of about 2,400 meters on several species of trees and other woody plants in all the provinces of the Philippine Islands. This paper will deal with only two common members of the family, *Loranthus philippensis* Cham. & Schlecht. and *Viscum Orientale* Willd.

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Loranthus. The genus *Loranthus* is represented in the Philippines by seventy-nine species, including one variety. The most common species in this genus is *Loranthus philippensis* Cham. & Schlecht., known locally as *dapo* or *dapong-kahoi.* Because of the similarity of the members of this genus, a description of this one will give an idea of the general appearance. The *Loranthus* is easily recognized by its vine-like stem which creeps on small branches and twigs of the host. From every node of the stem grow the root-like suckers and these penetrate into the bark of the plant to which they are attached. The twigs and the leaves, especially the lower surface, are covered with a brownish bloom.

Loranthus is botanically described as a "much branched coarse parasitic shrub. Twigs, grayish brown farinose. Leaves simple, opposite, elliptic or ovately elliptic, broadly obtuse, base rounded and often shallowly cordate, 6 to 10 cm. long, 4 to 7 cm. wide below the middle, petiole 1 cm. long, midrib conspicuous, the ascending nerves quite evident. Inflorescence lateral, densely fascicled, racemose, farinose, with few to several flowers toward the distal end; fruit a pseudo-berry or drupe, small, obovoidly elongated, thickly covered with grayish white farina, smooth". The seed is very small and around it is a layer of a very sticky substance. It is endemic and parasitic on a number of different hosts, the most common ones being lansones and citrus, two of the most valuable fruit trees in the Philippines.

Viscum. The genus *Viscum,* known in Europe as mistletoe, is represented in the Philippines by four species, the most common one being *Viscum orientale* Willd. Like *Loranthus,* it grows or attaches itself on various species of trees and has a destructive effect upon them.

According to the *Encyclopedia Britannica,* the members of the genus *Viscum* are deadly parasites, though slow in their action. The *Viscum* called hyphear is useful for fattening cattle if they are hardy enough to withstand the purgative effect it produces at first. *Viscum* is medicinally of value as an emollient in cases of tumor, ulcers and the like.

Viscum is botanically described as a "dense, rather large, numerously branched shrub; branches terete, greenish, opposite, conspicuously nodulose; leaves simple, opposite, greenish, very short petioled, ovate to linear, the smaller one lance-shaped, obscurely 3-nerved, costate-reticulate, 3 to 4 cm. long and 1 to 2 cm. wide. Flowers in sessile or short peduncled clusters, very small. Fruits small, globose, yellowish when ripe, with viscous juice."

METHOD OF DISSEMINATION

Both *Loranthus* and *Viscum* are disseminated by berry-eating birds which feed upon the pulp of the berries in the absence of other foods. As has been stated elsewhere in this paper, the fruit of both species contains a sticky material, known as viscin. The layer of viscin prevents the birds that eat the berry from swallowing the seed. They scrape it from their bills on a branch, where it adheres to the bark. The viscid pulp soon hardens, affording a protection to the seed. Other agents of dissemination when the berries are fully ripe are rain and strong winds. When ripe the seeds become soft and fall very easily; when washed or blown against branches of trees, they are crushed and the seeds affixed in the sticky viscin. (Bray, 1910.)

METHOD OF ATTACK

Under favorable conditions, the seeds germinate as soon as they are glued fast. In germination, the sucker-roots (haustoria) penetrate the bark to the wood and a connection is established with the vascular tissue of the host. When the parasite is well established upon the host it deprives it of mineral nutrients and certain amounts of elaborated food materials, so that the portion of the host beyond the parasite is starved and later on dies. (See fig. 1 and 2). "The growth of the plant is slow, and its durability is proportionately great, its death being determined generally by that of the tree on which it has established itself." When the host dies, eventually the parasite dies also.

VARIETAL SUSCEPTIBILITY

Why is it that certain species are affected and others are not? It is very difficult to draw a definite conclusion as to varietal susceptibility, since the amount of infection upon a given species seems to vary with the locality. Apparently any species within the range of the mature parasites may be affected. The following factors, based upon the experience of the writer, are considered:

1. The plants infected produce either edible fruits or seeds.
2. More infections are found on solitary and exposed trees than in a large body of forest. Hence, it is considered that light requirement of the parasites is an important factor.
3. The host plants are evergreen, so afford protection to the birds from heat, wind, rain, etc.
4. The host plants produce spongy epidermal tissue of the bark. When the birds wipe off their beaks on this, the seeds will easily stick to it.
5. The host plants produce showy inflorescences of various colors, which attract birds to the plants.

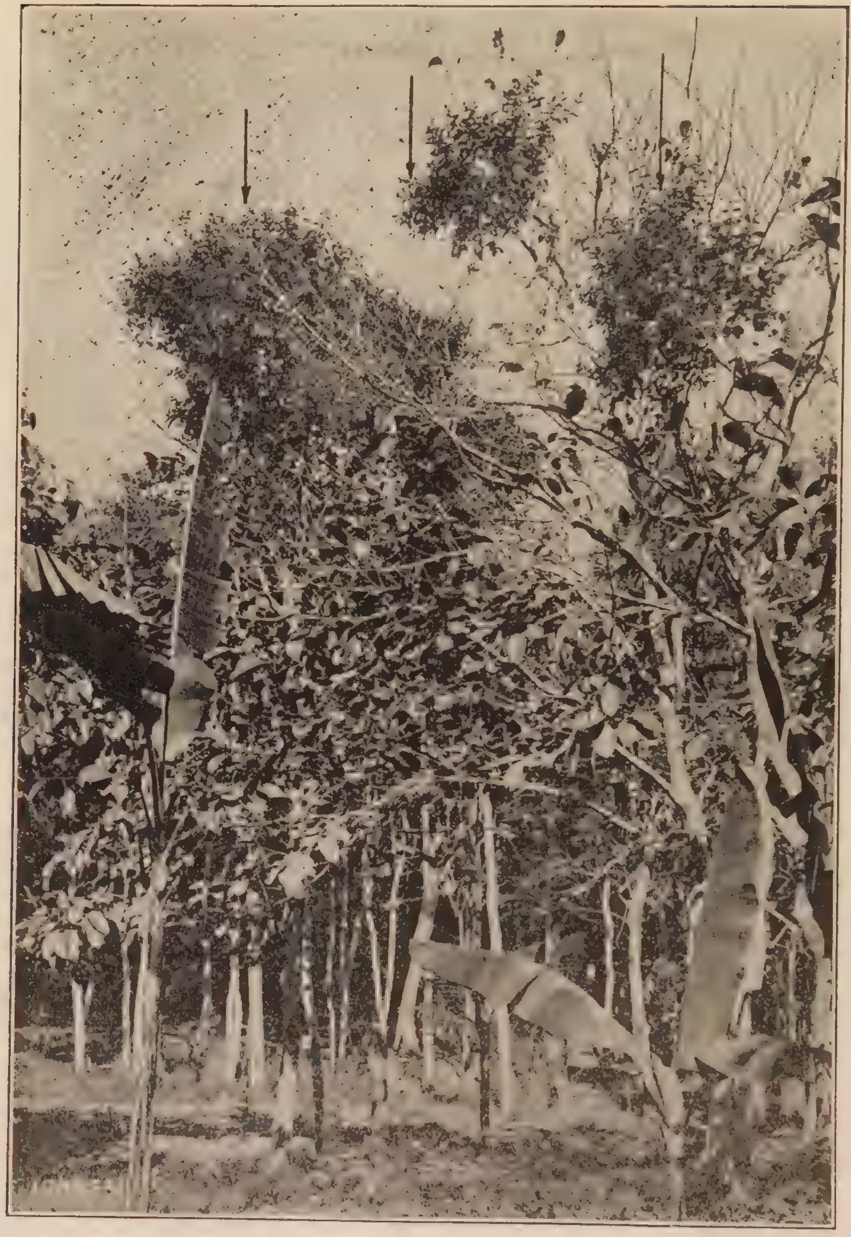

Fig. 1.—*Loranthus* (indicated by arrows) on banaba (*Legerstroemia speciosa*). Note the dry twigs of the host. (Forestry plantation, Los Baños, Laguna). (Photograph by Bureau of Forestry).

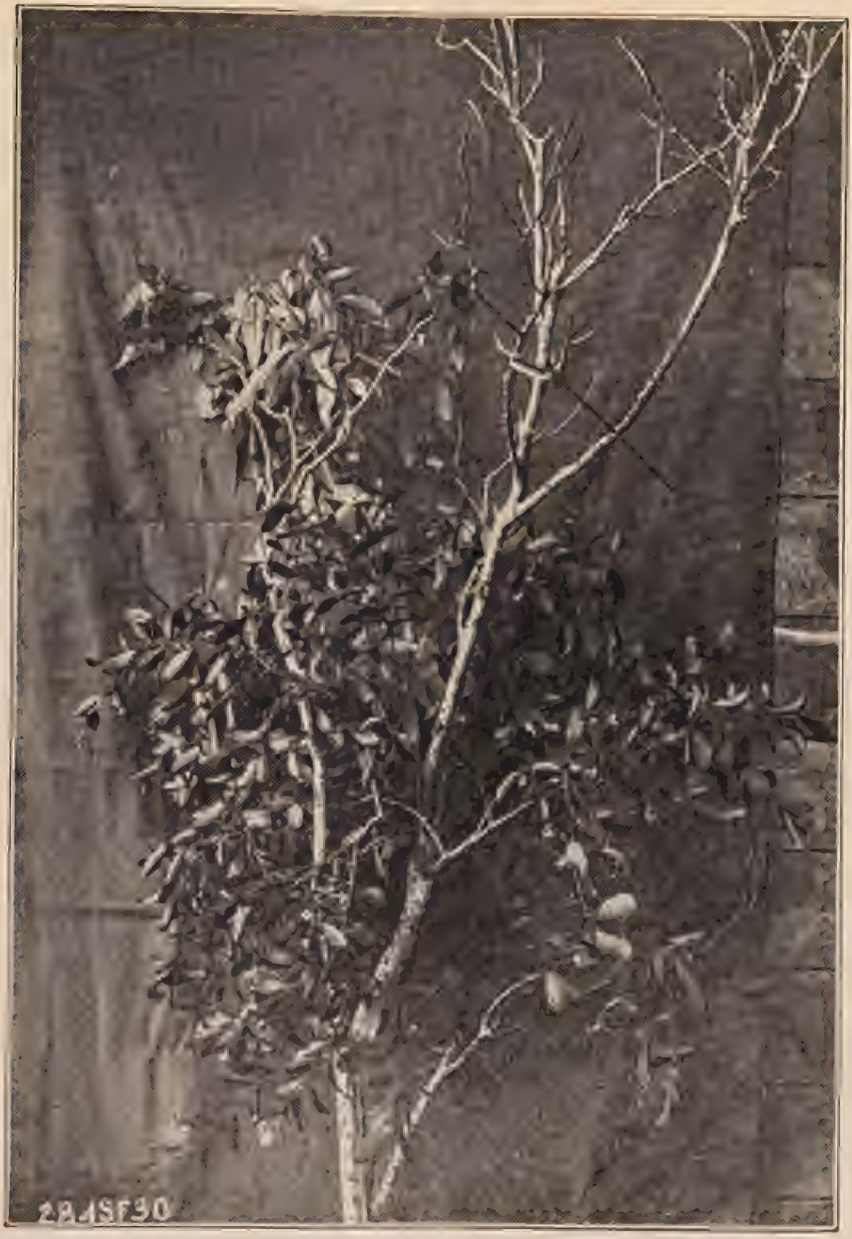

Fig. 2.—*Viscum orientale* on Banato (*Mallotus philippensis*) indicated by arrow. Note the dead branches of the host. College of Agriculture, Laguna. (Photograph by Bureau of Forestry.)

A list of woody plants found to be infected with either *Loranthus* or *Viscum* follows:

LORANTHUS

A. Forest trees

COMMON NAMES	LATIN NAMES
The Baletes	Ficus spp.
Banaba	Lagerstroemia speciosa (Linn.) Pers.
Batitinan	L. piriformis Koehne
Balobo	Diplodiscus paniculatus Turcz.
Batikuling	Litsea spp.
Benguet pine	Pinus insularis Endl.
Dao	Dracontemelum dao (Blco.) Merr.
Kayumanis	Clausena anisum-olens (Blco.) Merr.
Kupang	Parkia javanica (Lam.) Merr.
Lanutan	Bombycidendron vidalianum (Naves) Merr.
Makaasim	Eugenia spp.
Malasambong	Vernonia vidalii Merr.
Oak	Quercus spp.
	Podocarpus spp.
	Hopea spp.
Balinghasai	Buchanania spp.
	Eurya spp.
Pototan, Langarai	Bruguiera spp.
Pili, Pagsahiñgin, etc.	Canarium spp.
Kamagong, Bolong-eta, etc.	Diospyros spp.
	Medinilla spp. (shrubs)
The Kalamansanai	Neonauclea spp.
B. Parang trees	
Anonang	Cordia dichotoma Forst.
Alagasi	Leucosyke capitellata (Poir.) Wedd.
Alagau	Premna odorata Blco.
Alagau-dagat	P. obtusifolia R. Br.
Banato	Mallotus philippensis (Lam.) Muell-Arg.
Danglin	Grewia multiflora Juss.
Duhat	Eugenia cumini (Linn.) Druce
Halimomog	Ehretia philippinensis A. DC.
Hauili	Ficus hauili Blco.
Ibaibaan	Glochidion philippicum (Cav.) C. B. Rob.
Lagundi	Vitex negundo Linn.
Lumbang	Aleurites moluccana Willd.
Sorot-daga	Fluggea virosa (Roxb.) Baill.
C. Horticultural trees	
Avocado	Persea americana Mill.
Dayap	Citrus aurantifolia Sw.
Kahel	Citrus aurantium Linn.
Kalamunding	C. mitis Blco.
Lukban	C. maxima (Burm.) Merr.
Naranjita	C. nobilis Lour.
Lansones	Lansium domesticum Correa
Mango	Mangifera indica Linn.
Kapok	Ceiba pentandra (L.) Gaertn.
Santol	Sandoricum koetjape (Burm.) Merr.
D. Ornamental plants	
Dama del Día	
Gumamela	Hibiscus rosa-sinensis Linn.
	Parmentiera cerifera Seem.
The Roses	Rosa spp.

VISCUM

A. Parang trees

Banato	Mallotus philippensis (Lam.) Muell-Arg.
Hinlaumo	M. ricinoides (Pers.) Muell-Arg.
Kahoi-dalaga	Mussaenda philippica A. Rich.
	Loranthus philippensis Cham. & Schlecht.
Danglin	Grewia multiflora Juss.

B. Horticultural trees

Same species as in *Loranthus*.

ECONOMIC IMPORTANCE

These parasites cause considerable damage to forest and fruit trees and ornamental plants. The writer found during his field trips that approximately 80 per cent of lansones in the province of Laguna are affected with these parasites. This observation is corroborated by the two surveys made by Forest Guards Canicosa and Garcia under the instruction of the writer in the barrios of Balimbing and Lasaan, in the municipality of Nagcarlang. Out of one hundred trees counted to determine how many were affected, eighty contained *Loranthus* of different species. Some of the trees were dead and others in a very deplorable condition. Unless proper precautions are taken, the time will come when the lansone will be a tree of the past in Laguna. In the opinion of the writer, a tree affected with this parasite may be comparable to a person affected with tuberculosis. The disease works slowly but surely.

Information secured by the writer from old people in Paete and also in Nagcarlang, indicates that when a lansone tree becomes affected with these parasites, it lives only for 5 to 6 years, depending upon the severity of the infection. According to the observation of the writer in our forestry plantation, when a forest tree is affected it lives for 7 to 8 years.

Loranthus is said to be medicinal when it is attached to Lagundi (*Vitex negundo*). Both the host and the parasite are gathered and boiled. The water is given to a person having a severe cough.

SUGGESTED METHOD OF CONTROL

As has been said, these parasites are not confined to horticultural trees, they also infest forest trees. Years ago, the forestry plantation of Lanutan, *Bombycidendron vidalianum* in Los Baños, Laguna, was badly attacked by this parasite. Some of the trees were in a deplorable condition and a few died. A campaign was conducted under Forest Supervisor Evaristo Tabat in which all the affected branches and twigs were cut off and now the remaining trees are vigorous and doing nicely.

The remedy is very simple. Whenever and wherever the parasites are found, they should be destroyed. The twigs or branches on which they are should be cut off and burned. The parts from which the branches are cut should be tarred or painted so as to prevent infection by fungi or plant diseases.

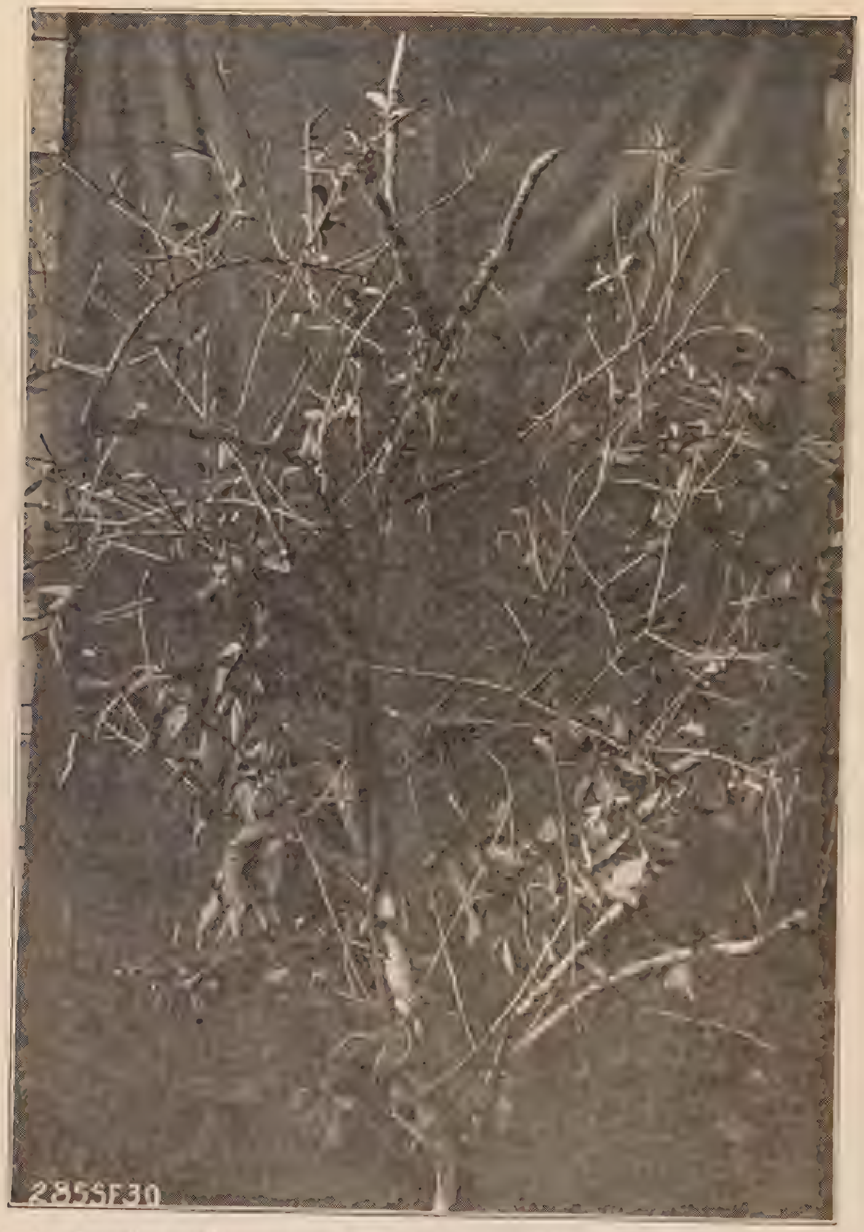

Fig. 3.—*Loranthus philippensis* on lukban (*Citrus maxima*). Note the dead condition of the host. College of Agriculture, Laguna. (Photograph by the Bureau of Forestry.)

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BIOLOGY OF COHOL (AMPULLARIA LUZONICA REEVE) A COMMON PHILIPPINE FRESH-WATER SNAIL[1]

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Of the Department of Entomology

WITH ONE PLATE AND THREE CHARTS

Snails rank high as food for the fishes in Laguna de Bay. Mane (1929) reported that snails held second place in importance as food for *kanduli* (*Arius* spp., Ariidae), the most important commercial food fish in this body of water. During certain periods of the year, the snails constitute as high as 76 per cent of the total food consumption of the fish. From all indications, other important food fishes of Laguna de Bay, such as *dalag* (*Ophicephalus striatus* Bloch,) and *hito* (*Clarias batrachus* (Bloch) are to a large extent dependent upon the snails for their food supply.

Ampullaria luzonica (*cohol*, Tagalog; *besocol*, Ilocano) is found in abundance in Laguna de Bay, its tributaries, and in the neighboring rice and zacate[2] fields, as well as in ponds or other water accumulations that are formed during the rainy season. It is not uncommon to find this species in the fish markets in Manila, where, to some extent, it is used as food. Indeed, farmers engaged in growing lowland rice find in the *cohol* a convenient substitute for fish in their diet. But during the dry season, these farmers esteem the *cohol* as a delicacy because at that time the gonads of the snails are full of eggs. These snails are found in large numbers by digging in the dry paddies where they are in a state of aestivation.

Cohol is also utilized by fishermen as bait for set lines locally known as *kitang*.

TIME AND PLACE OF THE PRESENT WORK

This work was begun in April, 1929, and closed in May, 1930, thus covering a period of fourteen months. Experiments and observations were conducted both under laboratory and field conditions. Laboratory studies were conducted in the Department of Entomology and in the College Limnological Station at Mayondon, Los Baños. Frequent trips were made in the fields in the municipalities of Los Baños and Bay, Laguna Province.

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[1] Thesis presented by Andres M. Nono for graduation, 1930, from the College of Agriculture, with the degree of Bachelor of Science in Agriculture, No. 327; Experiment Station contribution No. 709. Prepared in the Department of Entomology under the direction of Assistant Professor Deogracias V. Villadolid.

[2] *Leersia hexandra* Linn., a forage grass which is cultivated commercially in irrigated fields.

OBJECTS OF THE PRESENT WORK

The objects of the present work were: (*a*) to follow the development and rate of growth of the ova; (*b*) to study the reproductive habits of the *cohol*; (*c*) to determine the post-embryonic rate of growth of the snail; (*d*) to determine the size at sexual maturity; (*e*) to make observations on the feeding habits and other ecological aspects.

MATERIALS AND METHODS

Field study

Collection of materials for study. The material for study was collected largely in Mayondon and in the rice paddies of the College of Agriculture. Zacate fields in Bay, Laguna, and on the shores of Laguna de Bay at Mayondon were visited at regular intervals for the purpose of making collections of eggs.

Study of reproductive and feeding habits. Frequent trips were made to the breeding and feeding areas. Observations were made on the manner of copulation and oviposition. The manner of feeding and the feeds eaten were also determined. During the dry season, the dry places which were swampy and inhabited by the *cohol* during the rainy season were dug up and the snails in aestivation were examined.

Laboratory methods

Measurement of ova. The ova were measured for the most part with the aid of a compound microscope which was fitted with an eyepiece micrometer. A portion of the ovary was teased out on a slide and measurements of the ova made until the desired number was obtained. For ova exceeding 0.98 mm. in diameter, measurements were made with a micrometer caliper graduated to 0.01 mm.

Studies on the rate of growth. To determine the rate of growth, young *cohol*, hatched at the same time, were reared in aquaria and small ponds constructed for the purpose in the field, up to the time they become sexually mature.

Measurements were made with the aid of a caliper which was provided with a vernier reading to 0.01 mm. The length of the snail was determined by measuring from the apex to the peristome (pl. I, fig. 1).

Sexual maturity. To determine the age and size at sexual maturity, series of dissections were made from time to time on snails representing different sizes. The smallest snails which contained mature ova and sperms were isolated and measured. In this connection the distinguishing sex features were carefully noted.

RESULTS AND DISCUSSIONS

Ampullaria luzonica is a dioecious snail. The testis is a yellowish mass that forms the spiral extending to the apex. The distal end is hooked. The testis is unpaired and has the form of a racemose gland made of numerous acini. It appears compact, with ramifications extending over the liver mass (pl. I, fig. 2). The spermatozoa are discharged through a duct leading to a dilatation, which is more or less incompletely closed at the end. This duct opens into the pallial cavity at the right side of the intestine. The unpaired spermiduct, or vas deferens, is continued into a seminal furrow, or groove, which extends to the extremities of the penis. The genital duct does not possess a well differentiated accessory organ. The penis is very prominent and is provided with a sac in which it is hidden at the right side of the body.

The ovary is brownish in color, irregular in shape, and imbedded in the distal part of the liver. The oviduct is a rather small, delicate, tortuous tube and is regarded as the excretory duct of the ovary. It leads to a yellowish brown spherical gland, the albumen gland (pl. I, fig. 3). This gland extends anteriorly, into an oblong, thick-walled dilatation of the oviduct, the uterus. This is the place where the eggs are stored prior to oviposition. The uterus is continued anteriorly into a thick-walled copulatory organ, the vagina. This, in turn, extends to the outside into the vulva and then to the genital orifice along the neighborhood of the anus. At the distal part of the albumen gland is a heart-shaped organ, the shell gland. This is connected to the uterus by a duct which supplies shell to the eggs while they are in the uterus.

History of the ova

Growth of the ova prior to oviposition. The development of the ova was followed from the earliest recognizable formation in the ovary up to the time they were spawned. Several batches of eggs were collected from the field and hatched in the laboratory. On October 25, 1929, about 150 young snails (one-day old) were placed in bamboo baskets and reared in ponds near the Limnological Station at Mayondon. Water hyacinths (*Eichornia crassipes* Solms) were allowed to grow on the surface of the water. The plants served as food and places for anchorage for the snails.

Dissection was begun April 10, 1930; by this time the snails had reached an average length of 26.5 mm. At this size, the snails were found to be about to reach sexual maturity. Two snails were dissected every two days, beginning April 10, 1930, to ascertain the condition of the gonads. When the ova in the ovary were about to develop, dissections were then made daily. The ova were examined by teasing a portion of the ovary out on a slide.

Chart 1 shows the frequency curves of the diameter of ova measured at daily intervals from April 19 to May 5, 1930. Each curve represents measurements of 150 ova taken from dissections of snails made at one time. The measurements made on April 19 and on April 20, 1930, showed that the ova measured from 0.006 to 0.016 mm. in diameter. Subsequent dissections, showed a progressive growth of the ova with a rate of increase in the upper diameter limit ranging from 0.002 to 0.006 mm. daily, until an upper diameter limit of 0.045 mm. was reached in the dissections made on April 24, 1930. These eggs were transparent, creamy white, with light granules around the nucleus.

Dissections made from April 25 to April 29, 1930, showed that the ova changed from transparent to opaque eggs, with prominent brownish chromatophores almost filling the cytoplasm. From April 26 they made a faster increment. The rate of daily increase in the upper diameter limit ranged from 0.01 to 0.02 mm. The eggs at this stage measured from 0.095 to 0.125 mm. in diameter.

On April 30, 1930, the opaque ova were found to be lodged in the oviduct, some of them already reaching the most proximal portion of that organ, just past the albumen gland. These eggs were provided with albumen enclosed in a gelatinous membrane. Dissections which were made from May 1 to May 3, 1930, showed this type of ova in the stage of rapid growth, the increase in the diameter of the upper size limit ranging from 0.05 to 0.5 mm. These eggs varied in size from 0.175 to 3.75 mm. in diameter. On May 4 and May 5, 1930, eggs measuring from 3.26 to 3.75 mm. in diameter were found to be lodged in the uterus, ready to be oviposited. These were the largest eggs found in the *cohol*. They occupied the most proximal portion of the uterus. They were gelatinous white in appearance. On exposure to light the outer covering of the eggs became hard and brittle, the color remaining white. On May 6, 1930, two batches of eggs were for the first time seen attached to the bulbs of the water hyacinth just above the surface of the water. There were 96 eggs in one batch and 103 in the other. The next day, May 7, three other batches of eggs were found attached to the roots of the water hyacinth. These eggs were clustered in a single mass by means of a white gelatinous substance which hardened upon exposure to the air (pl. I, fig. 4).

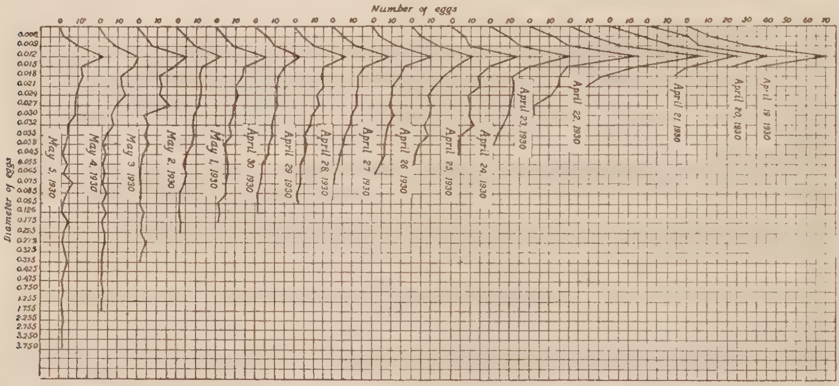

Chart 1.—Frequency curves of diameters of ova prior to oviposition, April 19, 1930, to May 5, 1930.

Incubation period. Ten pairs of copulating snails were collected and reared in a small pond near the Limnological Station. The dates of the first oviposition and also the dates of the first hatching of the eggs were recorded. The difference between the two periods in days was taken as the incubation period of the eggs. In order to determine the effect of environmental difference on the duration of the incubation period, experiments were made under four distinct conditions as follows:

(1) *In the laboratory.* Eggs were placed in petri dishes containing a little water on a table about one meter high along the concrete wall inside the zoölogical laboratory. The concrete floor of the building is on almost the same level as the ground. The window shutters are made of translucent white shells cut in small squares set in a wooden frame. Near the cultures these windows were closed most of the time. Obviously, the cultures were fairly well protected from the ground, rain, and direct sunlight.

(2) In Laguna de Bay under shade just on the surface of the water.

(3) In Laguna de Bay, exposed to sun above the level of the water.

(4) In Laguna de Bay, under water.

The results are given in table 2.

It may be seen in table 2 that the period of incubation under laboratory conditions varied from 15 to 20 days with an average of 17.3 days. The incubation period in Laguna de Bay, under shade, ranged from 14 to 16 days with an average of 15.5 days. In the same table it may also be seen that the lot exposed to the sunlight and the lot submerged under water did not hatch. The average incubation period in Laguna de Bay, under shade, when the eggs barely touched the surface of the water, was 15.5 days, which was shorter than the period (17.3 days) in the laboratory. In the laboratory the windows were closed most of the time near the cultures and the temperature was lower than in the open shade.

Larval stages. Seven days after oviposition, a dark-colored embryo which began to assume the shape of the snail was formed. (pl. I, fig. 5).

Twelve days after oviposition the small *cohol* became provided with shells and were becoming well differentiated from the albuminous material. (pl. I, fig. 6).

Fourteen days after oviposition, or about a day before hatching, the *cohol* within the egg shell became very much enlarged (pl. I, fig. 7). At that stage, fissures appeared in almost all directions in the egg shells. Simultaneous with this breaking of the shells, the eggs became soft as a result of the rupture of the shell coverings. The white gelatinous color changed to a darker white. The change of color was probably due to the reflected color of the shell inside.

Reproductive habits

Copulation. In studying the procedure and manner of copulation, the snails were observed in their natural habitats and in cultures in the laboratory.

Copulation occurred at any time of the day on rainy days and occasionally among crowded plants on hot days. The snails were observed to copulate in all seasons of the year in places where there was a continuous supply of water. The sexually mature male approached the female and clung to the shell of the latter. When the female was not in heat, she closed her operculum, sank and settled to the bottom of the water. Otherwise, she held the operculum wide open, and the male gradually moved to the right side of the basal aperture, where the genital orifice is located. The female attached herself to a floating object, as roots and leaves of plants, and even to the soil along the moist side of the dikes. In the act of copulation they faced each other so that the male had its aperture facing downward and the female upward or vice versa. In some cases they floated during the process. They held each other by means of their muscular feet. Copulation was found to last from one to two hours, after which time, they separated and closed their opercula, sank and settled at the bottom of the water. After at least five minutes' rest at the bottom they began to be active again and the first thing they did was to search for food.

Manner of oviposition. In studying the manner of oviposition of the snail, close observations were conducted from July, 1929 to May, 1930, in the rice paddies of the Experiment Station of the College and in bodies of water near the Limnological Station.

In the rice paddies of the Experiment Station, the dikes were the only place where the *cohol* were observed laying eggs. The snail selects a site free from disturbances and the sides of the dikes satisfy this condition. It was of interest to note that the *cohol* always laid its eggs on objects at water level.

After locating a suitable place for egg laying, the *cohol* attaches its muscular foot firmly against the grass roots and then secretes a milky white gelatinous substance from its genital orifice. This secretion apparently serves the double purpose of lubricant to facilitate the passage of eggs on to the roots of plants or on the soil on the side of the dikes and to hold the eggs in a mass. As the eggs pass out from the genital orifice, they are pushed to the left side and carefully arranged one above the other in a single mass. The muscular foot is used in thus arranging the eggs as they are extruded from the genital orifice. The *cohol* does not leave the eggs immediately after laying them; she covers and smooths them for a while with her muscular foot. It will be noted that the foot has other uses besides being an organ of attachment and locomotion.

In oviposition, the aperture of the snail faces downward. Oviposition may take place any time of the day. It was observed, however, that the snails were more active in oviposition on rainy days. Deposition of one batch of eggs lasts from thirty minutes to one hour.

The breeding places in ponds near the Limnological Station were found to be different from those found in the lowland rice fields. Floating plants were the usual objects upon which the snails were found to lay eggs in the ponds. Floating objects are more suitable for the anchorage of eggs as they follow the water level all the time and hence the eggs are kept moist and prevented from being submerged in water during the period of incubation. It will be recalled that eggs were not hatched when submerged in water.

Height of fecundity. In determining the period during which fecundity was at its peak, a certain area (about 1000 square meters) in the breeding ground in ponds near the Limnological Station was fenced and observations on the appearance of batches of eggs were made. Collection of eggs was made at weekly intervals from May 14, 1929, to May 9, 1930. The number of batches of eggs for each collection was determined.

The results of these determinations are shown in table 3. Apparently, the peak of egg laying in Los Baños was in the period covering the rainy months of July, August, September, and October.

No eggs could be collected during May and June, 1929, and in April, 1930. This absence of eggs was due to the fact that the breeding ground under observation was dry during these months, and the snails had buried themselves in the soil for rest (aestivation).

The first appearance of eggs in the area designated for observations and collections in the Limnological Station was on July 14, 1929. Heavy rains on July 8, 9, and 10, had flooded the area where the snails were aestivating. As a result of the rain the *cohol* emerged from the soil and started to copulate, and four days later, batches of eggs were found.

Growth of the snails

Effect of volume of media on the rate of growth. One-day snails were used in this determination. In order to determine the effect of volume of media on the rate of growth, the cultures were treated as follows:

(1) Lots I and II, ten snails to a lot. Each lot was reared in a jar containing three liters of water.

(2) Lots III and IV, five snails to a lot. Each lot was reared in a jar containing three liters of water.

Tap water was used in the cultures. The snails were given fresh leaves of camote (*Ipomoea batatas* Linn.) as food. The water and feeds in each jar were changed every three days. They were carefully removed so as not to disturb the snails as little as possible. From July 28, 1929, to February 3, 1930, the snails were measured at weekly intervals. Chart 2 shows the results of this determination. It will be seen from the chart that from the first to the fourteenth week the snails in lots I and II with 0.3 liter to a snail of the media did not show any appreciable difference in growth from the snails in lots III and IV, with 0.6 liter of the media to a snail. From the fifteenth to the twenty-seventh week the average length and average width of snails in lots III and IV remained above the average length and average width of snails in lots I and II. At the age of twenty-seven weeks the snails in lots I and II had attained an average length of 21.78 mm. with an average width of 16.6 mm. In lots III and IV, the snails had attained an average length of 24.46 mm. with an average width of 19.2 mm. Thus at this age, the *cohol* with 0.6 liter to a snail of the media is 2.78 mm. longer and 2.6 mm. wider than the *cohol* with only 0.3 liter of water to the snail. It seems justifiable to attribute so great a difference to the volume of the media, inasmuch as the care given was practically the same in all lots. However, it must be pointed out that the water fouled quicker in lots I and II than in lots III and IV. Crabb (1929) states that volume of media appears to have relatively little effect on growth of isolated *Lymnaena stagnalis appressa*, an American species of fresh-water snail, provided foulness is not permitted.

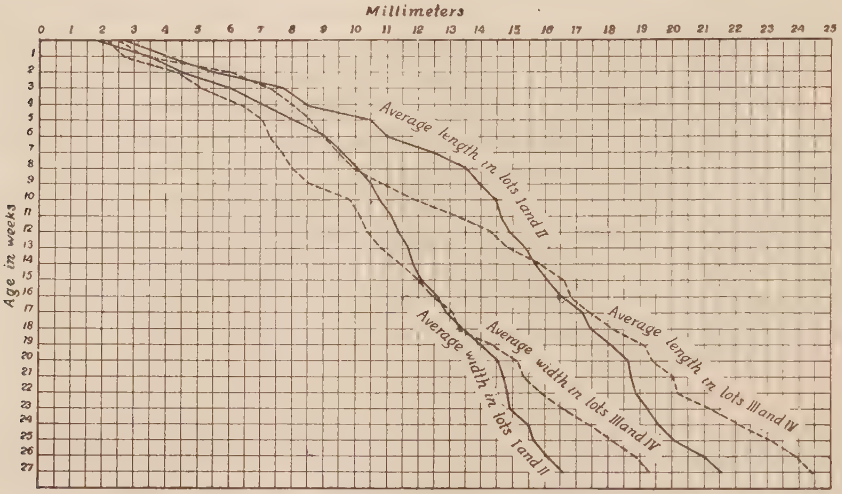

Chart 2.—Growth of snails under laboratory conditions. July 28, 1929, to February 3, 1930.

At the end of the experiment the snails were examined and found to be free from larval trematodes, which if present may cause retardation in the growth of the snails.

Comparison of the growth of cohol under field and laboratory conditions. Lots V and VI were run at the same time with the rate of growth determination in the laboratory, that is from July 28, 1929, to February 3, 1930. One-day snails were reared in ponds with an area of one square meter each and with water about 30 to 40 cm. deep. Water hyacinths and *Ceratophyllum demersum* Linn. were allowed to grow in the ponds so that the condition of the culture approached more or less the natural habitat of the *cohol*.

Chart 3 shows the comparison of the rate of growth of snails under laboratory and field conditions.

The snails reared in ponds grew faster than those reared in the laboratory. After twenty-seven weeks, lots I and II had snails with an average length of 21.78 mm. and an average weekly growth of 0.70 mm. in lots III and IV, the snails had an average length of 24.46 mm. and an average weekly increment in length of 0.81 mm.; while the snails in lots V and VI had an average length of 29.18 mm. and an average weekly growth of 0.98 mm. From the above data, it may be concluded that the condition in the ponds was favorable for the rapid growth of the snails.

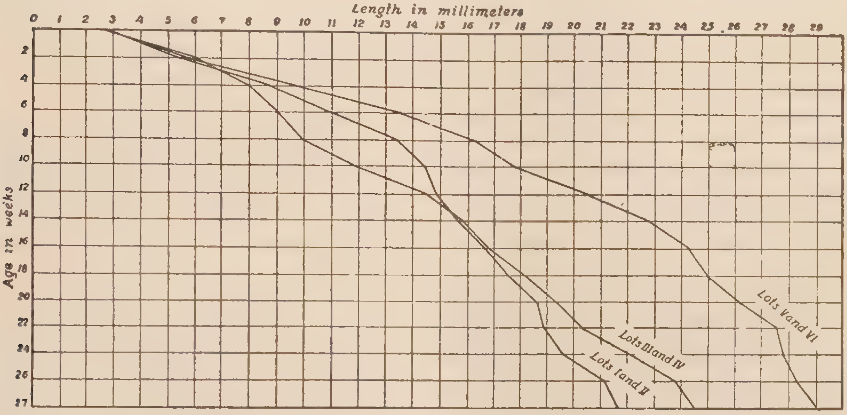

Chart 3.—Growth of snails under field and laboratory conditions. July 28, 1929, to February 3, 1930.

Lots I and II, 10 snails to a lot. Each lot was reared under laboratory conditions, in a jar containing three liters of tap water. The snails were fed with fresh leaves of camote (*Ipomoea batatas* Linn.). The water and feeds were replaced every three days.

Lots III and IV, 5 snails to a lot. Each lot was reared and treated under conditions identical with those for lots I and II.

Lots V and VI, 14 to 15 snails to a lot. Each lot was reared in a small pond near the College Limnological Station at Mayondon. Each pond was approximately one square meter in area and 30 to 40 centimeters deep. Water hyacinths, *Eichornia crassipes* Solms., and *Ceratophyllum demersum* Linn. were allowed to grow in the ponds so that the conditions of the cultures approached as much as possible the natural habitat of the *cohol.*

Size and age at sexual maturity

Size at sexual maturity. In determining the size at sexual maturity, a series of dissections of 100 snails representing groups of different size were considered in each examination from June 19, 1929 to May 5, 1930. The smallest sexually mature snails were isolated by using the presence of mature ova as criterion for sexually mature females and the presence of spermatozoa for sexually mature males.

Table 5 shows that the male measuring from 26.5 to 29.3 mm. in length with an average of 27.61 mm. and females measuring from 27.9 to 32.3 mm. in length with an average of 29.12 mm. were sexually mature.

Age at sexual maturity. In the discussion on the rate of growth of the snail under field conditions, it is stated that the snails had attained an average length of 29.18 mm. at the age of 27 weeks. The average size of sexually mature snails collected from their natural habitat was the same as that of those obtained in the experiment.

Feeding habits of the cohol

Observations were conducted at different places in the irrigated zacate fields, lowland rice paddies, irrigation ditches, and in the ponds included in the reservation of the College Limnological Station where the snails were found in abundance and were undisturbed.

While feeding, the snail usually holds fast and clings to the plants, hence, the manner of feeding in their natural habitat could be observed without much difficulty. The snails were closely watched while in the act of feeding and their food was determined. Observations on the feeding habits of the snails in the aquaria were made also. As the snail eats succulent food which upon passing through the radula (pl. I, fig. 8) becomes reduced into minute unrecognizable particles, identification of food items in the stomach was found to be impracticable.

It was found, that the snails are strictly vegetarian. They feed on leaves, stems, and roots of aquatic plants. The bulbs of the water hyacinth were observed to have been completely eaten at times by the hungry snails. *Ceratophyllum demersum* Linn. is much relished by the *cohol*. Among other plants found to be the food of *cohol* were: *Ipomoea reptans* Linn., *Pistia stratiotes* Linn., and occasionally, *Cyperus radiatus* Vohl.

The snails were observed to feed on the younger leaves and stems. It was observed that filamentous algae had been fed upon by the snails. When the ponds became dry the snails were observed to congregate and feed upon mud and organic matter. It was observed in the laboratory cultures in connection with the rate of growth experiments that there was a marked difference in the manner of feeding of the young *cohol* and the adult. The young after hatching were not observed to feed directly on the young leaves of camote (*Ipomoea batatas* Linn.). The young leaves were examined after four days of confinement of the young snails in the aquaria but there was no sign of feeding on either surface of the leaves. But when the egg shells with dried yolk and albuminous material were placed in the aquaria, the small *cohol* clung to the egg[4] shells and fed upon the materials. After ten days the young *cohol* were observed to feed on the nether epidermal surface of the camote leaves. In general, it was observed that the young and small *cohol* preferred to feed upon the epidermal surface of the leaves. Adults were observed to be voracious feeders on the camote leaves, cutting them into small pieces until the whole leaf including the veins, was eaten.

Habitat and method of escaping adverse conditions

The *cohol* was observed to be strictly a lowland form. It is commonly found in lowland rice paddies, irrigated zacate fields, and the marshy lowlands of Laguna de Bay and its tributaries. It is found at the mouth of rivers, but not in rocky mountain streams and running brooks. Places of this kind do not provide the snails with proper sites for breeding and feeding activities.

In the rice paddies at the College Experiment Station the snails were seen in large numbers on the sides of dikes during the rainy season from July to October, 1929. They were then observed to be at the height of their breeding activity. On hot days, especially at noon, they were seen along the sides of the dikes clinging to the roots of plants in the rice paddies or else they were found congregated under the shade or a shelter where the water was cool.

At the approach of the dry season, they burrowed deep in the mud and became inactive. Preparatory to this summer rest, the *cohol* developed a thicker shell in response to the approaching dry condition. They were observed to go as deep as from 8 to 15 cm. in the soil, remaining in that condition from six to seven months. It was also seen that prior to aestivation, they usually congregated in one or two pairs, as shown by their being collected in groups when dug out during the dry season.

At the approach of the rainy season, about July or August, when the paddies became flooded, the snails came out of the soil and again engaged actively in their feeding and breeding occupations.

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[4] The eggs were analyzed by Dr. F. T. Adriano of the Division of Analytical Chemistry. The result of the analysis follows:

CONSTITUENTS	SAMPLE I	SAMPLE II	AVERAGE
	per cent	*per cent*	*per cent*
Moisture			81.70
Ash			11.92
	based on ash	based on fresh	
Phosphorus (P_2O_5)	0.11	0.013	
Calcium (CaO)	73.29	8.740	
Silica (SiO_2)	2.44	0.290	

In irrigated fields the *cohol* were not found to aestivate. They were active throughout the year, and spawning was apparently continuous, although not so high in the months from July to October. On hot days, the *cohol* in the irrigated zacate fields were found among the roots of plants in the irrigation ditches, where the water was cooler than elsewhere. The *cohol* were often seen congregated on hot days in water overflowing the weirs of irrigation ditches. On rainy days they were seen on exposed areas of the irrigation ditches.

Factors causing scarcity

Several factors which might influence the abundance or scarcity of snails were observed. Among those that may be mentioned are the following:

Infestation of larval trematodes. Specimens which were infested with larval flukes were found on dissection with gonads incapable of reproduction. Large numbers of dead snails were found upon examination to have been killed apparently by serious trematode infestations.

Tubangui (1928) reported the following larval trematodes present in the body of the snails in Los Baños, Laguna.

Cercaria parvomelaniae Tubangui
C. redicystica "
C. philippindica "
C. melaniasperata "
C. maquilingi "
C. lagunaensis "
C. rarissima "
C. maitimensis "
C. dorsecauda "

In piles of grass and roots of aquatic plants wild mallards were seen feeding upon the *cohol.*

These snails are taken in large numbers by fishermen either for bait for set lines (*kitang*) or for food.

SUMMARY AND CONCLUSIONS

1. *Ampullaria luzonica* is found in abundance in Laguna de Bay and its tributaries. It is to some extent used as food by the inhabitants of the region around Laguna de Bay. It is also used by fishermen as bait for their hooks and set lines.

2. Very little is known concerning the biology of *cohol.* The present study was an attempt to ascertain the rate of growth and development of the ova; to study the reproductive habits; to determine the post-embryonic rate of growth of the snail; to determine the size and age at sexual maturity; and to make observations on the feeding habits and mode of tiding over adverse conditions.

3. The ova found within the ovaries of the *cohol* may be classified as follows:

a. The smallest ova which are transparent creamy white with light granules around the nucleus. They measure 6μ to 45μ in diameter.

b. The opaque ova, with larger granules filling the cytoplasm. They measure from 95μ to 125μ in diameter.

c. The mature ova are gelatinous white. They measure from 0.175 to 3.75 mm. in diameter.

4. It takes six days for the transparent ova to turn opaque.

5. The mature ova make their appearance about eleven days after sexual maturity of the snail.

6. The eggs are laid in batches numbering from 96 to 103 to a batch. They are present in single masses in which they are fastened together by a white gelatinous substance which hardens upon exposure to air.

7. Incubation period of eggs in the open, under shade where the eggs barely touch the surface of the water ranged from 14 to 16 days with an average of 15.5 days; and in the laboratory, from 15 to 20 days with an average of 17.3 days. In the open, exposed to sun where the eggs were situated above the surface of the water and under the water, they failed to hatch.

8. Copulation occurs at any time of the day, usually on rainy days and occasionally among crowded plants on hot days. The process lasts about two hours.

9. *Cohol* deposit eggs on the sides of dikes and among roots, stems, and leaves of floating plants. Deposition of one batch of eggs lasts from thirty minutes to one hour.

10. The peak of fecundity of *A. luzonica* took place in a period covering July, August, September, and October, 1929, which in Los Baños is the rainy season.

11. Volume of media affects the growth of the snail; the retardation of growth apparently being due to the relative foulness of the media in the more crowded cultures.

12. The snails reared in their natural habitat grew faster than those reared in the laboratory.

13. The male *cohol* attained sexual maturity when of an average length of 27.61 mm.; the female when of an average length of 29.12 mm. They attained sexual maturity at the age of 27 weeks.

14. The *cohol* were strictly vegetarian; their food consisted of roots, stems, and leaves of many aquatic plants, such as *Ceratophyllum demersum*, *Ipomoea reptans*, *Pistia striatiotes*, *Eichornia crassipes*, filamentous algae, and occasionally *Cyperus radiatus*. On dissection it was found that organic matter and mud had been eaten by the *cohol*. In the laboratory the snail was induced to feed on camote leaves (*Ipomoea batatas*). The small

four-day *cohol* did not feed on the leaves of plants but on the dried albumen and yolk materials of the eggs that had not hatched.

15. *Cohol* is strictly a lowland form. It is commonly found in lowland rice fields, irrigated zacate fields, and in the marshes along the shores of Laguna de Bay and the mouths of its tributaries.

16. During the dry season, the snails bury themselves at a depth of from 8 to 15 cm. in the soil, remaining there for six to seven months. In irrigated fields and in places where there is water throughout the year, snails do not aestivate and their spawning activity is continuous throughout the year.

17. Among factors that tend to deplete the *cohol* in Laguna de Bay, the most important are: larval trematodes, wild ducks, and excessive use of snails as bait by fishermen.

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TABLE 1

Diameter of ova prior to oviposition. (Ova were taken from two snails every day)

CLASS VALUE DIAMETER OF EGG	FREQUENCY OR NUMBER IN EACH CLASS																
	April 19, 1930	April 20, 1930	April 21, 1930	April 22, 1930	April 23, 1930	April 24, 1930	April 25, 1930	April 26, 1930	April 27, 1930	April 28, 1930	April 29, 1930	April 30, 1930	May 1, 1930	May 2, 1930	May 3, 1930	May 4, 1930	May 5, 1930
millimeter																	
0.005—0.007	14	21	18	12	13	9	7	5	4	5	4	6	4	5	4	3	2
0.008—0.010	30	26	33	23	19	15	9	14	13	12	10	10	8	9	7	8	10
0.011—0.013	70	60	65	67	55	40	35	31	30	29	26	23	25	22	25	20	21
0.014—0.016	36	43	20	24	17	19	19	23	16	16	15	15	14	13	19	18	12
0.017—0.099	0	0	14	16	15	11	14	16	14	13	14	12	13	12	12	12	13
0.020—0.022	0	0	0	8	14	12	15	12	10	13	15	11	10	13	13	13	10
0.023—0.025	0	0	0	0	11	11	8	8	10	12	11	11	11	12	12	14	9
0.026—0.028	0	0	0	0	3	10	10	10	9	12	12	11	9	11	16	8	8
0.029—0.031	0	0	0	0	3	9	9	9	11	9	8	9	8	8	3	6	8
0.032—0.033	0	0	0	0	0	7	11	7	8	8	7	8	6	7	5	7	4
0.034—0.036	0	0	0	0	0	4	5	8	7	6	5	8	7	7	4	4	4
0.037—0.039	0	0	0	0	0	3	4	4	6	5	6	6	4	6	5	2	3
0.040—0.050	0	0	0	0	0	0	4	2	6	4	5	6	5	5	3	4	1
0.051—0.060	0	0	0	0	0	0	0	1	4	3	3	4	6	4	2	2	4
0.061—0.070	0	0	0	0	0	0	0	0	2	2	3	4	6	5	1	3	2
0.071—0.080	0	0	0	0	0	0	0	0	0	1	3	3	5	4	2	1	6
0.081—0.090	0	0	0	0	0	0	0	0	0	0	1	1	5	2	2	4	3
0.091—0.100	0	0	0	0	0	0	0	0	0	0	2	1	1	1	1	1	2
0.101—0.150	0	0	0	0	0	0	0	0	0	0	0	1	2	1	3	4	1
0.151—0.200	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	2	4
0.201—0.250	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	2
0.251—0.300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	3	1
0.301—0.350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	3
0.351—0.400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	4
0.401—0.450	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3
0.451—0.500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
0.501—1.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
1.001—1.500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
1.501—2.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
2.001—2.500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
2.501—3.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3.001—3.500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3.501—4.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Total.......	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150

TABLE 2

Incubation period

	LOTS IN THE LABORATORY			LOTS IN LAGUNA DE BAY			
	I	II	III	Shade, surface of		Lot submerged in water	Lot exposed to sunlight
				I	II	*1929*	*1929*
	1929	*1929*	*1929*	*1929*	*1929*		
Eggs laid	11-VII	11-VII	11-VII	11-VII	12-VII	11-VII	11-VII
Hatched	27-VII	27-VII	28-VII	26-VII	26-VII	Did not hatch	Did not hatch
Incubation period	16 days	16 days	17 days	15 days	14 days	—	—
Eggs laid	22-VII	25-VII	27-VII	21-VII	24-VII	21-VII	21-VII
Hatched	6-VIII	10-VIII	12-VIII	6-VIII	8-VIII	Did not hatch	Did not hatch
Incubation period	15 days	16 days	16 days	16 days	15 days	—	—
Eggs laid	1-IX	14-IX	14-IX	23-VIII	1-IX	23-VIII	23-VIII
Hatched	19-IX	2-IX	1-X	9-IX	17-IX	Did not hatch	Did not hatch
Incubation period	19 days	18 days	17 days	16 days	17 days	—	—
Eggs laid	15-X	15-X	18-X	3-X	3-IX	3-IX	3-IX
Hatched	2-XI	3-XI	5-XI	19-X	18-X	Did not hatch	Did not hatch
Incubation period	19 days	20 days	18 days	16 days	15 days	—	—
Maximum incubation period	19 days	20 days	18 days	16 days	15 days	—	—
Minimum incubation period	15 days	16 days	16 days	15 days	14 days	—	—
Average incubation period in day	17.25	17.5	17.25	15.75	15.25	—	—

TABLE 3

Fluctuation in oviposition in the breeding ground

DATE OF OBSERVATION	BATCHES OF EGGS	MONTHLY TOTAL
1929		
14–V	0	0
24–V	0	
1–VI	0	0
7–VI	0	
16–VI	0	
23–VI	0	
1–VII	0	83
7–VII	0	
14–VII	4	
21–VII	50	
28–VII	29	
4–VIII	17	62
11–VIII	20	
18–VIII	15	
25–VIII	10	
1–IX	15	61
8–IX	9	
15–IX	17	
22–IX	8	
29–IX	12	
6–X	17	60
15–X	18	
22–X	14	
29–X	11	
5–XI	7	38
12–XI	13	
19–XI	4	
26–XI	14	
3–XII	6	24
10–XII	5	
17–XII	4	
24–XII	9	
1930		
4–I	2	17
11–I	5	
18–I	8	
25–I	2	
1–II	4	12
8–II	3	
15–II	2	
22–II	3	
28–II	0	
7–III	2	5
14–III	3	
21–III	0	
28–III	0	
4–IV	0	0
11–IV	0	
16–IV	0	
25–IV	0	
2–V	0	0
9–V	0	

TABLE 4

Showing the growth of Ampullaria luzonica under laboratory conditions. (Ten snails measured in lot I and in lot II; five snails measured in lot III and in lot IV)

Age in weeks	LOT I				LOT II					
	Average length	Average increase in length	Average width	Average increase in width	Average length	Average increase in length	Average width	Average increase in width	Average of lots I and II	
									length	width
	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.
Initial measurement	2.78		2.33		2.75		2.33		2.76	2.33
1	4.10	1.32	3.60	1.27	4.10	1.25	3.60	0.27	4.10	3.60
2	5.54	1.44	4.53	0.93	5.53	1.43	4.55	0.95	5.53	4.54
3	7.79	2.25	6.23	1.70	7.78	2.25	6.24	1.69	7.79	6.23
4	7.80	2.01	7.20	0.97	9.39	1.61	7.21	0.97	8.59	7.21
5	10.56	2.76	8.10	0.90	10.56	1.17	8.21	1.00	10.56	8.18
6	11.15	0.59	9.05	0.95	11.15	0.59	9.05	0.84	11.15	9.05
7	12.53	1.38	9.65	0.60	12.52	1.37	9.65	0.60	12.52	9.65
8	13.50	0.97	10.25	0.60	13.56	1.04	10.26	0.61	13.53	10.25
9	13.93	0.43	10.55	0.30	13.94	0.48	10.54	0.38	13.93	10.54
10	14.53	0.60	10.81	0.26	14.54	0.60	10.83	0.29	14.53	10.82
11	14.64	0.11	11.12	0.31	14.67	0.13	11.15	0.32	14.65	11.13
12	14.92	0.32	11.30	0.18	14.93	0.26	11.31	0.16	14.92	11.30
13	15.44	0.52	11.67	0.37	15.45	0.52	11.68	0.37	15.44	11.67
14	15.76	0.32	11.81	0.14	15.81	0.36	11.85	0.27	15.78	11.83
15	16.22	0.46	12.17	0.36	16.25	0.44	12.21	0.36	16.23	12.19
16	16.63	0.41	12.76	0.59	16.65	0.40	12.71	0.50	16.64	12.73
17	17.29	0.66	12.87	0.11	17.31	0.66	12.92	0.21	17.30	12.89
18	17.57	0.28	13.52	0.65	17.59	0.28	13.56	0.64	17.58	13.54
19	18.23	0.66	14.08	0.56	18.27	0.68	14.18	0.62	18.25	14.13
20	18.62	0.39	14.64	0.56	18.70	0.43	14.65	0.47	18.69	14.64
21	18.80	0.18	14.72	0.08	18.85	0.15	14.75	0.10	18.82	14.73
22	18.95	0.15	14.89	0.17	18.95	0.10	14.91	0.16	18.95	14.90
23	19.34	0.39	15.04	0.15	19.36	0.41	15.05	0.14	19.35	15.04
24	19.63	0.29	15.54	0.50	19.64	0.28	15.55	0.50	19.63	15.54
25	20.26	0.63	15.70	0.16	20.28	0.64	15.71	0.16	20.27	15.70
26	21.03	0.77	16.12	0.42	21.18	0.90	16.10	0.39	21.10	16.11
27	21.87	0.84	16.81	0.69	21.70	0.62	16.42	0.32	21.78	16.61
Average weekly increase	——	0.70	——	0.53	——	0.70	——	0.52	——	——

TABLE 4—(Continued)

Showing the growth of Ampullaria luzonica under laboratory conditions. (Ten snails measured in lot I and in lot II; five snails measured in lot III and in lot IV)

	LOT III				LOT IV					
Age in weeks	Average length	Average increase in length	Average width	Average increase in width	Average length	Average increase in length	Average width	Average increase in width	Average of lots III and IV	
									length	width
Initial measurement	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
	2.55		2.24		2.55		2.24		2.55	2.24
1	3.97	1.42	2.87	0.63	3.16	0.61	2.54	0.30	3.56	2.65
2	5.50	1.53	3.39	0.52	6.67	3.51	5.41	2.87	6.08	4.40
3	6.08	0.58	3.95	0.56	7.75	1.08	6.50	1.09	6.91	5.22
4	7.75	1.67	5.76	1.81	8.28	0.53	7.15	0.65	8.01	6.45
5	8.34	0.59	6.54	0.78	8.85	0.57	7.50	0.35	8.59	7.02
6	8.76	0.42	6.89	0.35	9.42	0.57	7.74	0.24	9.09	7.31
7	9.28	0.52	7.54	0.65	9.77	0.35	7.92	0.18	9.52	7.73
8	9.71	0.43	8.09	0.55	10.23	0.46	8.01	0.09	9.97	8.05
9	10.85	1.14	8.64	0.55	10.92	0.69	8.56	0.55	10.88	8.60
10	11.86	1.01	9.79	1.15	11.87	0.95	9.80	1.24	11.86	9.79
11	13.28	1.42	10.17	0.38	13.38	1.51	10.18	0.38	13.33	10.13
12	14.40	1.12	10.39	0.22	14.53	1.15	10.43	0.35	14.46	10.41
13	14.83	0.43	10.71	0.32	14.86	0.33	10.75	0.32	14.84	10.73
14	15.78	0.95	11.51	0.80	15.78	0.92	11.63	0.88	15.78	11.57
15	16.63	0.85	12.20	0.69	16.64	0.86	12.23	0.60	16.63	12.21
16	16.80	0.17	12.52	0.32	16.83	0.19	12.53	0.30	16.81	12.52
17	17.47	0.67	13.10	0.58	17.47	0.64	13.10	0.47	17.47	13.10
18	18.29	0.82	13.33	0.23	18.29	0.82	13.35	0.25	18.29	13.34
19	19.13	0.84	14.48	1.15	19.13	0.84	14.49	1.14	19.13	14.40
20	19.44	0.31	15.20	0.72	19.45	0.32	15.31	0.82	19.44	15.25
21	20.11	0.77	15.31	0.11	20.13	0.68	15.41	0.10	20.12	15.36
22	20.36	0.25	15.96	0.65	20.36	0.23	15.98	0.57	20.36	15.97
23	21.37	1.01	16.65	0.69	21.39	1.03	16.66	0.68	21.38	16.65
24	22.28	0.91	17.38	0.73	22.31	0.92	17.38	0.72	22.29	17.38
25	23.18	0.90	18.28	0.90	23.41	1.10	18.23	0.85	23.29	18.25
26	23.98	0.80	18.91	0.63	23.96	0.55	18.94	0.71	23.97	18.92
27	24.32	0.34	19.01	0.10	24.61	0.65	19.41	0.47	24.46	19.21
Average weekly increase	——	0.80	——	0.62	——	0.81	——	0.63	——	——

TABLE 5

Showing the growth of Ampullaria luzonica under laboratory and under fields conditions

AGE IN WEEKS	LOTS IN THE FIELDS							AVERAGE LENGTH OF SNAILS IN LAB.	
	V			VI					
	Number of snails measured	Average length	Average increase in length	Number of snails measured	Average length	Average increase in length	Average of lots V and VI	Lots I and II	Lots III and IV
		mm.	*mm.*		*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
Initial measurement	15	2.73		14	2.53		2.63	2.76	2.55
2	15	5.22	2.49	14	6.07	3.54	5.64	5.53	6.08
4	15	9.22	4.00	14	10.23	4.16	9.72	8.59	8.01
6	15	13.81	3.59	14	13.89	3.66	13.85	11.15	9.09
8	15	15.70	1.89	14	17.06	3.17	16.38	13.53	9.97
10	15	17.48	1.78	14	18.45	1.39	17.96	14.53	11.86
12	15	20.85	3.37	14	20.21	1.76	20.53	14.92	14.46
14	15	23.46	2.61	14	22.51	2.30	22.98	15.78	15.78
16	15	24.35	0.89	14	24.35	1.84	24.35	16.64	16.81
18	15	25.05	0.70	14	25.04	0.69	25.04	17.59	18.29
20	15	26.94	1.89	14	27.72	0.68	26.33	18.69	19.44
22	15	27.35	0.41	14	27.95	2.23	27.65	18.95	20.36
24	15	27.55	0.20	14	28.34	0.49	27.94	19.63	22.29
26	15	28.15	0.60	14	28.74	0.40	28.44	21.10	23.97
27	15	29.17	1.02	14	29.19	0.45	29.18	21.78	24.46
Average weekly growth	——	——	0.98		——	——	0.98	——	——

TABLE 6

Showing minimum length of sexually mature snails. (One hundred snails were considered in each examination)

DATE	MINIMUM SIZE OF MATURE SNAILS	
	Males	Females
1929	*mm.*	*mm.*
19–VI	26.9	28.7
3–VII	27.0	29.2
15–VII	27.3	28.9
10–VIII	28.0	28.5
26–VIII	27.0	28.1
10–IX	27.0	30.0
24–IX	28.0	32.3
8–X	27.1	29.0
22–X	27.3	28.9
5–XI	27.3	28.1
19–XI	27.3	29.1
26–XI	27.8	28.3
3–XII	27.2	28.2
10–XII	27.3	29.1
17–XII	27.3	29.3
24–XII	27.5	29.5
29–XII	27.5	28.7
1930		
7–I	26.5	27.9
14–I	27.1	28.5
21–I	28.2	28.3
28–I	27.9	29.8
12–II	28.1	29.9
26–II	28.3	30.1
10–III	27.6	28.8
24–III	28.5	29.3
7–IV	29.3	30.3
21–IV	28.3	30.2
5–V	28.6	29.8
Minimum	26.5	27.9
Maximum	29.3	32.3
Average	27.61	29.1

EXPLANATION OF PLATE

(Drawings by Daniel M. Buñag)

Fig. 1. Mature *Ampullaria luzonica Reeve*, × 4.
Fig. 2. Mature male *A. luzonica*, dissected to show the testis which forms the spiral extending to the apex, × 1 (*ts*, testis).
Fig. 3. Mature *A. luzonica*. mantle pushed back to show the albumen gland, × 4 (*ag*, albumen gland).
Fig. 4. A batch of newly-laid eggs of *A. luzonica*, × 1.
Fig. 5. Egg of *A. luzonica*, seven days after oviposition, × 5.
Fig. 6. Egg of *A. luzonica*, twelve days after oviposition, × 5.
Fig. 7. Egg of *A. luzonica*, fourteen days after oviposition, × 5.
Fig. 8. Young *A. luzonica*, seven days after hatching, × 16.
Fig. 9. Young *A. luzonica*, 21 days after hatching, × 8.7.
Fig. 10. Young *A. luzonica*, 28 days after hatching, × 7.8.
Fig. 11. *A. luzonica*, 120 days after hatching, × 4.
Fig. 12. Radula of *A. luzonica*, × 100.

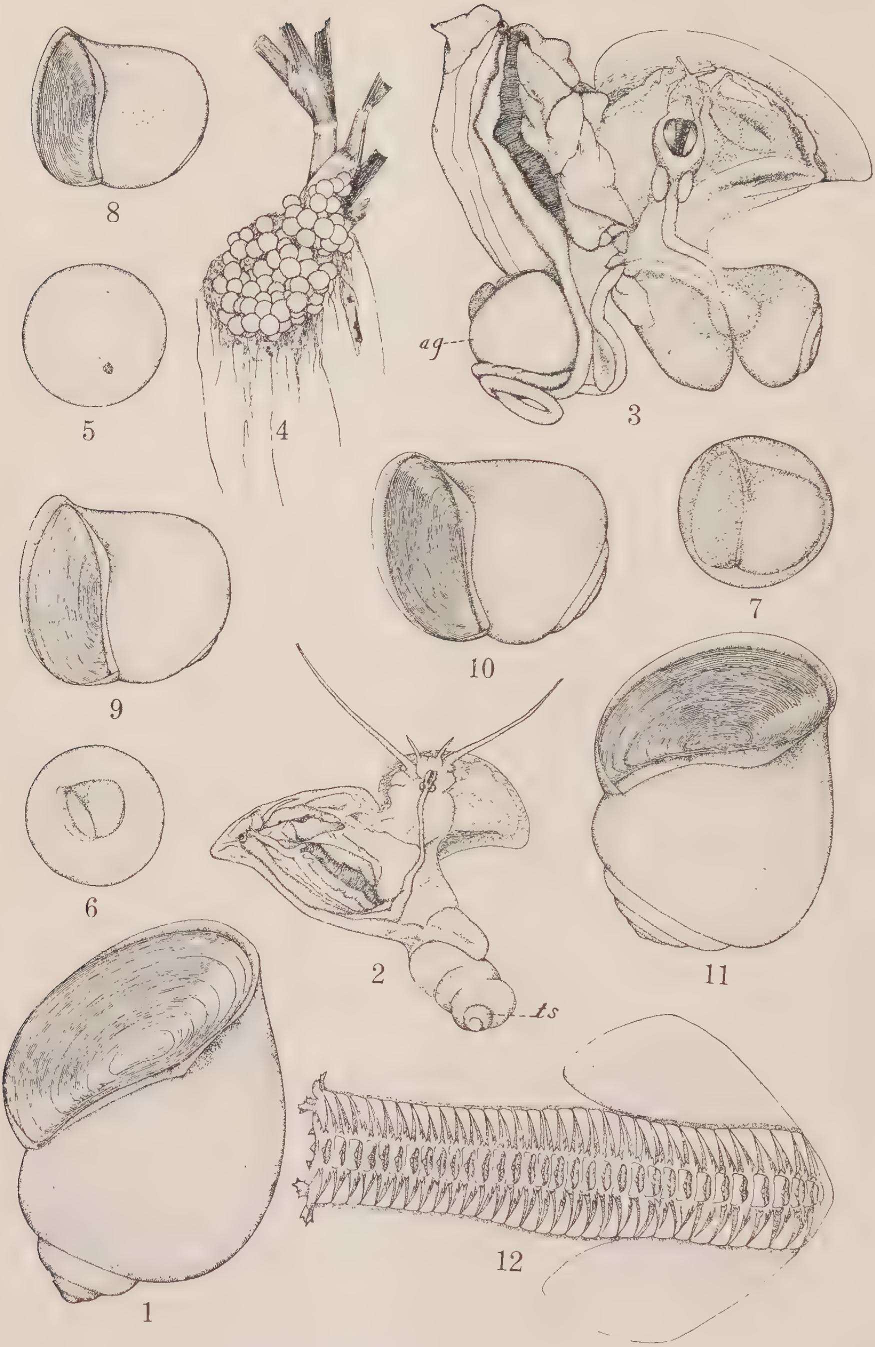
8
4
3
ag
5
10
7
9
11
6
2
ts
1
12

PLATE I

BAMBOO AS DRAIN "TILE"[1]

JESUS P. MAMISAO

WITH NINE TEXT FIGURES AND ONE CHART

INTRODUCTION

Drainage is needed in places where water is in excess. Too much water in the soil is injurious to crops just as too little water is equally unfavorable. Little attention has been given to the problem of draining water-logged land in the Philippines.

Elliot (1919) lists the effects of drainage on the soil as follows:

1. The aëration of the soil is improved.
2. Its texture and structure are so modified that it becomes friable.
3. The depth of the soil available to plant life is increased.
4. The condition of the soil becomes favorable to the life of the nitro-bacteria.

Drainage can be accomplished in either of two ways: (1) by open drainage, or (2) by close drainage. There are many advantages in using close or tile drainage. Some of these are:

Space is saved. If open ditches are used, much space is wasted, as generally an area on both sides is not cultivated.

Field operations are not interrupted. If there are open ditches across or around the field, the transfer of implements from one field to another will not be easy. Plowing the field will also be hindered.

Open drainage may cause gullying. Gullying in the field is not an unusual occurrence, especially during the rainy season. Open ditches may increase the gullying; there is no danger of this with tile drainage.

Much work has been done on clay, wood, and concrete tile drainage but very little, if any, on bamboo tube drainage. To add to this little knowledge this work was undertaken, the object of which was to study the possibility of bamboo for drain "tile". Bamboo grows very abundantly in many parts of the Islands, so sources for materials are always accessible.

The question of whether it would be economical in the long run to use bamboo drain tubes is not treated in this paper. The following points were considered:

1. Strength of bamboo tubes used as tile. That is, as to whether the tube will be crushed in the soil as a result of field operations.

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[1] Thesis presented for graduation, 1930, with the degree of Bachelor of Agriculture from the College of Agriculture No. 328; Experiment Station contribution No. 710. Prepared in the Department of Agricultural Engineering under the direction of Dr. Alexander Gordon.

2. Preservative for the tubes.
3. Durability of the tubes in the soil.
4. Effectiveness in draining.

The land where this work was conducted unquestionably required drainage. Durano (1927) studied the drainage characteristics of this land. He found that the poorly drained field was underlaid with heavy clay soil.

No publication on bamboo for tile was found by the writer. Of course, much has been written on the growth and cultivation of bamboo, its commerce and uses, but nothing was found on its use as drain material. It is not uncommon, however, to find Filipino farmers using bamboo as water conduits for irrigation.

The work here reported covered a period of twenty-two months, from March, 1928 to December, 1929. The work was conducted in lot 4, division XXIX of the College Experiment Station and in the laboratory of the Department of Agricultural Engineering.

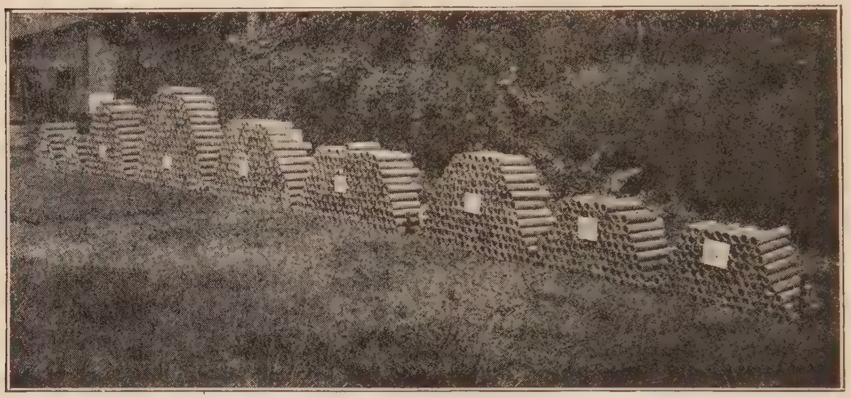

Fig. 1.—Piles of bamboo tubes classified according to inside diamater.

MATERIALS AND METHODS

Cutting and classifying the tubes

Fifty-five bamboo stems (*Bambusa spinosa* Roxb.) were cut in March, 1928. The stems were cut squarely between nodes, and tubes of approximately a foot-length were obtained; to minimize waste, the sawing was made as close to the nodes as possible.

The tubes were then classified into eight groups as follows: (1) tubes having inside diameters falling between 2 and 2¼ inches; (2) between 2¼ and 2½ inches; (3) between 2½ and 2¾ inches; (4) between 2¾ and 3 inches; (5) between 3 and 3¼ inches; (6) between 3¼ and 3½ inches; (7) between 3½ and 3¾ inches; and (8) between 3¾ and 4 inches. (See fig. 1). All measurements of the inside and outside diameters of the tubes were made with the use of Vernier's micro-caliper.

Chemical treatments

Each group was further divided into four sub-groups A, B, C, and D. Group A was treated with coal tar; group B with a salt solution containing 1 part salt and 2 parts water by weight; group C with a 1:4 salt solution; and group D served as a control.

Treating with tar. The tar was placed in an open bath. The tubes were then immersed in it until every portion outside and inside of each tube was completely covered with tar.

Treating with salt solutions. Two salt-solution treatments were made. One solution had a consistency of 1 part salt (NaCl) in 2 parts water; the other, 1 part salt in 4 parts water. The prepared salt solutions were placed in the baths. Group B tubes were immersed in the 1:2 solution; group C tubes in the 1:4 solution. The time of immersion was 24 hours.

Locating the drain lines

According to Elliot (1919) one should be able by inspection to get a general idea as to where the drain lines should be established. Inspection of the field also helps to determine just what kind of survey should be undertaken.

In this work the preliminary survey of the field was made with the help of the writer's adviser. The field is a piece of land in the College Experiment Station. According to Professor Mariano B. Raymundo, former superintendent of the Experiment Station, this field is always water-logged during the rainy season. Yasay and Sol de Villa (1926) and Durano (1927) verified this statement.

Contour map. A contour map of the field was made (fig. 2). The difference in elevation between the contour lines was one foot. This map, together with the information obtained from others about the character of the soil, was a valuable guide in establishing the drainage system.

The drain lines were located in the lowest portion of the field, which is poorly drained, especially during the rainy season. A main line and three lateral branches comprised the drainage system. For convenience, the main line was designated *C-D-E-F-G;* the first lateral branch, *A-B-C;* second lateral branch, *I-H-D;* and the third, *J-K-L-M-E.* The main line has a total length of 209.91 feet (63.9 meters); *A-B-C*, 144.48 feet (44.0 meters); *I-H-D-*, 144.00 feet (43.9 meters); and *J-K-L-M-E*, 233.85 feet (71.3 meters).

Profile map. The profiles of the established drain lines were then made. (See fig. 3). This map served as a guide in determining the depths of the drain at various points. At point *A*, the drain was 2 feet deep. One per cent grade was proposed. With the use of the profile map, the approximate depth at every point along the line was known. The depth of the outlet of the main at *G* was about 3 feet.

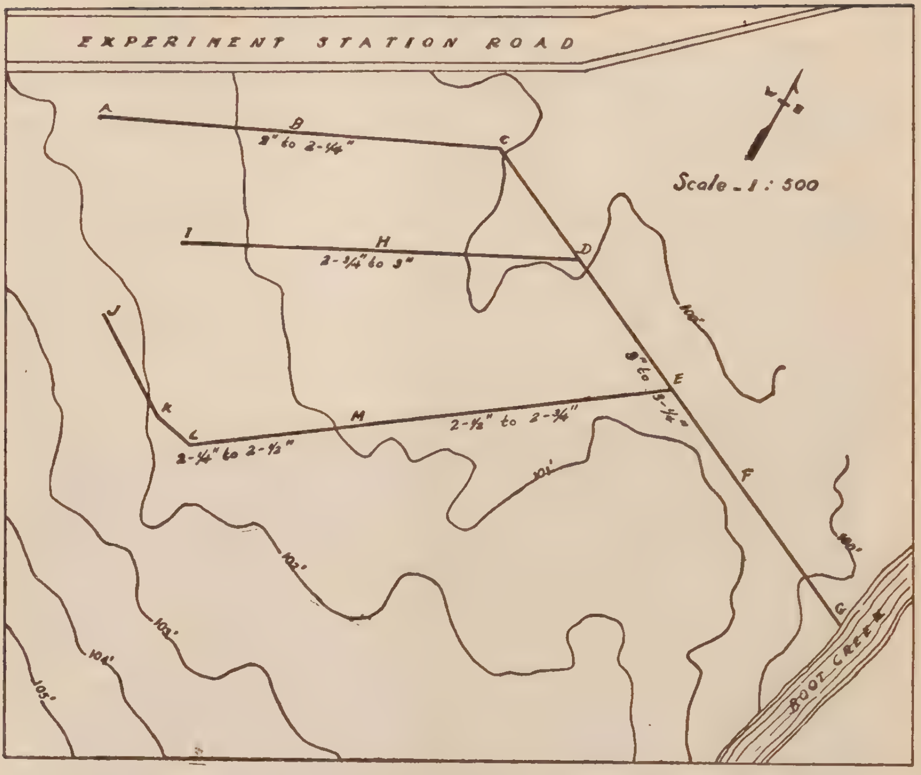
EXPERIMENT STATION ROAD
Scale - 1 : 500
A
B
2" to 2-1/4"
C
I
H
2-3/4" to 3"
D
J
K
L
2-1/4" to 2-1/2"
M
2-1/2" to 2-3/4"
E
3" to 3-1/4"
F
G
100'
101'
102'
103'
104'
105'
ROOT CREEK

Fig. 2.—Contour map of the field showing the "Drain Tile" system.

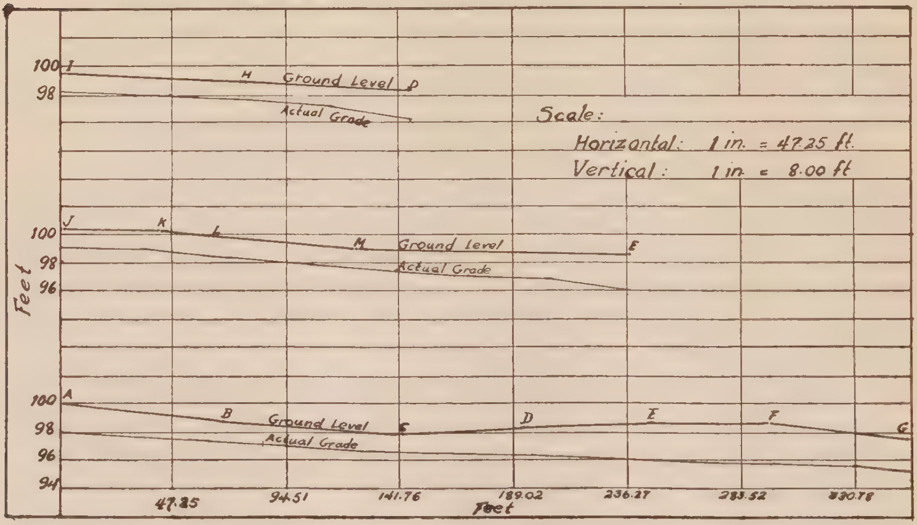

Fig. 3.—Profiles of the drain lines.

Excavations

Digging of the ditch. After the cuts at the different points of the drain lines were determined in the profile map, digging was started. A digging hoe and a shovel were found very handy in the work. The usual practice in ditch construction is to start at the outlet and proceed up grade. This practice is a precaution against effect of rain. As this work was done in the dry season, this precaution was not observed in choosing a place to start digging. *A* was the starting point and the work progressed downward to the main line, and finally to the outlet at *G*. After the line *A-B-C-D-E-F-G* was finished, laterals *I-H-D* and *J-K-L-M-E* followed starting at *D* and *E*, respectively; the digging progressed up grade. As much as possible, the bottom of the ditch was made plane and level according to grade.

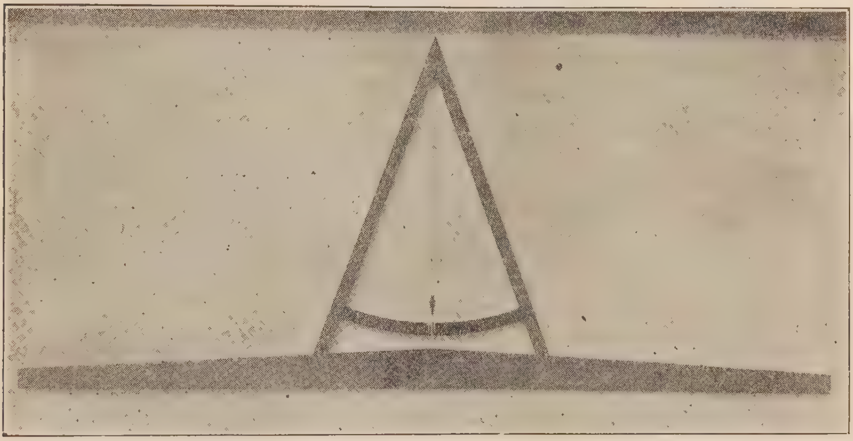

Fig. 4.—Leveling board. Note the three white lines below the plumb bob. When the plumb bob points to either of the two short lines the grade is one per cent.

Fixing the grade. The grade of the bottom of the ditch was easily fixed with the use of a leveling board. The proposed grade of the drain was one per cent. Actually, however, the grade of the line *A-B-D-E-F-G* was 0.76 per cent; *I-H-D*, 1.31 per cent; and *J-K-L-M-E*, 1.32 per cent. The leveling board was so fixed that when used it showed at once whether the grade was about one per cent or not. A plumb bob hung at the vertex of the triangle; in the contrivance was the pointer. (See fig. 4).

Laying the "tile"

In the first lateral branch *A-B-C*, 2 to 2¼-inch tubes were laid; in *C-D* of the main line, 2¼ to 2½-inch tubes; in *D-E-F-G*, 3 to 3¼-inch tubes; in the second lateral branch, 2¾ to 3-inch tubes; and in the third lateral branch, 2¼ to 2½ and 2½ to 2¾-inch tubes. (See fig. 2). The tubes were carefully laid in the bottom of the ditch, care being taken to fit the ends as closely as possible. The order of setting the tubes was as follows: a tar-treated tube was placed first, followed by a 1:2 salt-treated tube, then a 1:4 salt-treated tube, and finally an untreated tube. The untreated tube was in turn followed by another tar-treated tube and so on in the same order as before. (See fig. 5).

The free ends of the three lateral branches were closed by pieces of board to keep the soil from getting into the tubes. To keep rodents and other small animals out of the tubes, the outlet was covered with a netted wire.

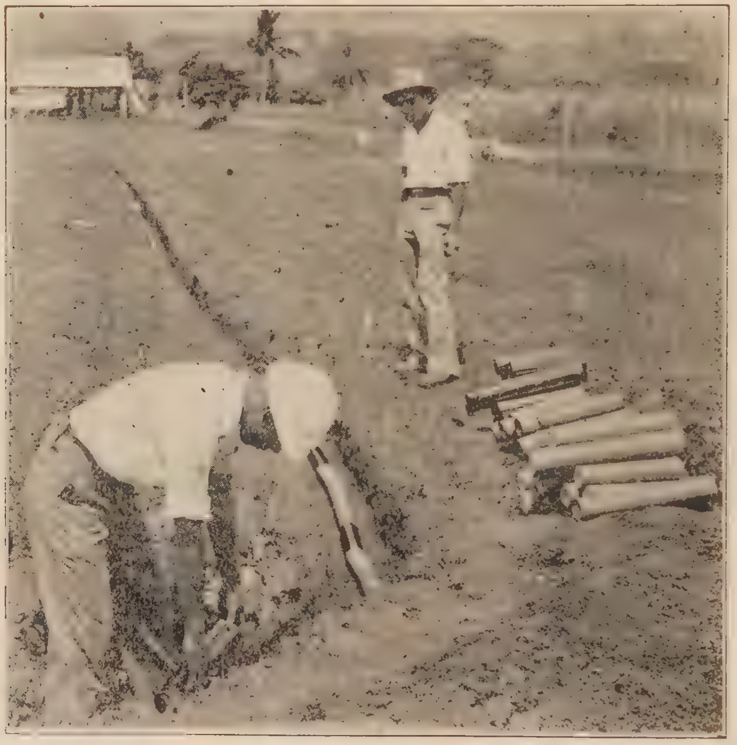

Fig. 5.—Laying the "tile". Note the black tubes. They have been treated with coal tar.

The method of preparing "L's" and "T's" is shown in figure 6.

All operations completed, the ditches were covered. The drainage system was laid.

Crushing the tubes

There were two devices used to determine the crushing strengths of the tubes. Both these devices were designed by Dr. Alexander Gordon of the Engineering Department. One was a lever machine and the other a jack screw machine.

Lever machine. Figure 7 shows the machine and its parts. The tube t is placed on a piece of board b on the platform s of the scale balance. On the tube is placed a crushing board c. Across c on a notch is placed a lever arm l pivoted under a piece of board f.

To break the tube a force E is applied at one end of l. At the same time the force tending to break the tube plus other forces, which will be mentioned later, are recorded by the balance at its scale.

Let that force recorded by the balance be R, the force necessary to break the tube be F, the weight of the tube and board b be W, then

$R = F + W$ or $F = R - W$.

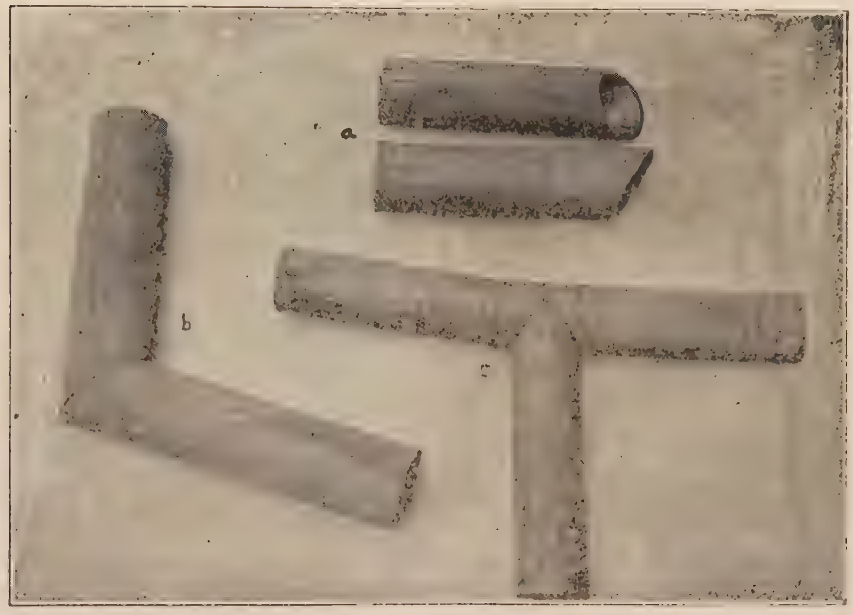

Fig. 6.—How tubes are joined. *a*, front and side view of tubes before joining; *b*, "L"; *c*, "T".

That is, the crushing strength of the tube equals the weight recorded by the balance minus the weight of the tube and the board on which it is laid.

Jack screw machine. In this device (see fig. 8), the jack screw is placed at the center of the platform of the balance. The tube to be crushed is placed between the board k on top of the jack screw j and a piece of board f over and across the platform of the balance. This serves as a press.

If the weight recorded by the balance is R and the weight of the jack screw plus the board k is W, then the crushing force $F = R - W$.

RESULTS AND DISCUSSIONS

Strength of the tubes as "tile"

According to the owner of the plantation the bamboo stems cut and tested were about one and one-half years old. Tables 1 and 2 show the breaking strength of the tubes in pounds per linear foot with corresponding diameter and thickness of the wall.

For the tubes having inside diameters of 3¼ to 3½ inches, the breaking strength ranged from 389 pounds when the thickness of the wall was 0.263 inch to 822 pounds when the thickness was 0.328 inch. When the inside diameters were 3 to 3¼ inches, the minimum breaking strength was 301 pounds per linear foot, the thickness of the wall being 0.263 inch; for 2¾ to 3 inches, the thickness of the wall, 0.237, the minimum breaking strength was 362 pounds per linear foot; for 2½ to 2¾ inches, thickness of the wall, 0.272, the minimum breaking strength was 341 pounds per linear foot; for 2¼ to 2½ inches, thickness of the wall, 0.218 inch, the minimum breaking strength was 329 pounds per linear foot; for 2 to 2¼ inches, thickness of the wall, 0.234 inch, the minimum breaking strength was 332 pounds per linear foot. Of all these stresses, the minimum breaking strength was 301 pounds per linear foot. It will be noticed that the minimum breaking strength is the one considered in the discussion to allow a greater factor of safety. The point is to determine whether the tubes could withstand the field forces.

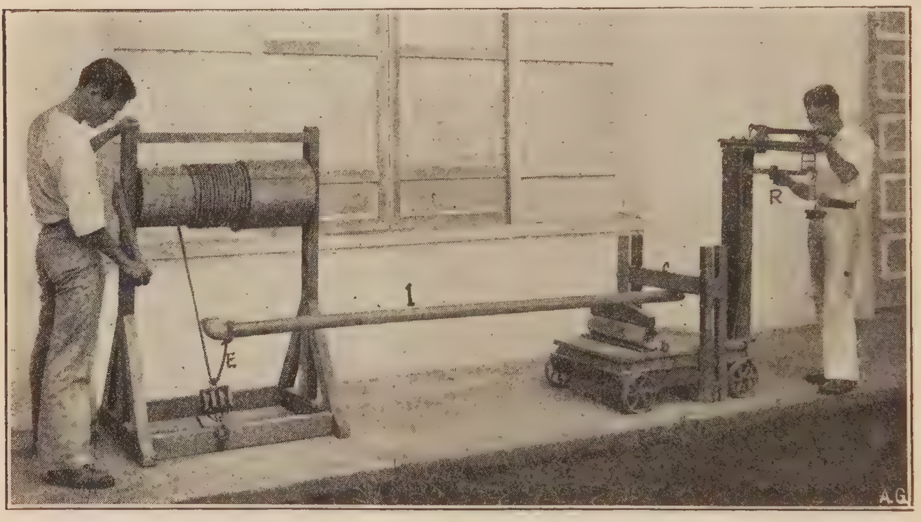

Fig. 7.—Lever machine. Note the tube in position for crushing. *t*, tube; *b*, pieces of board; *s*, platform of the scale balance; *c*, crushing board; *l*, lever arm; *f*, a piece of board serving as pivot; *E*, force applied; *R*, recorded force by the balance.

Parsons (1915) gives Marston's formula for earth pressure on pipes as:

$$W = C\ w\ B^2,$$

where

W = total pressure on pipe in lbs. per linear foot.

C = A constant. Its value depends upon $\frac{H}{B}$.

H = Height of fill in feet over the pipe.

B = Width of trench at the top of the pipe.

w = Unit weight of filling materials in lbs. per cubic foot. (Values given in table XVI of Parsons (1915).

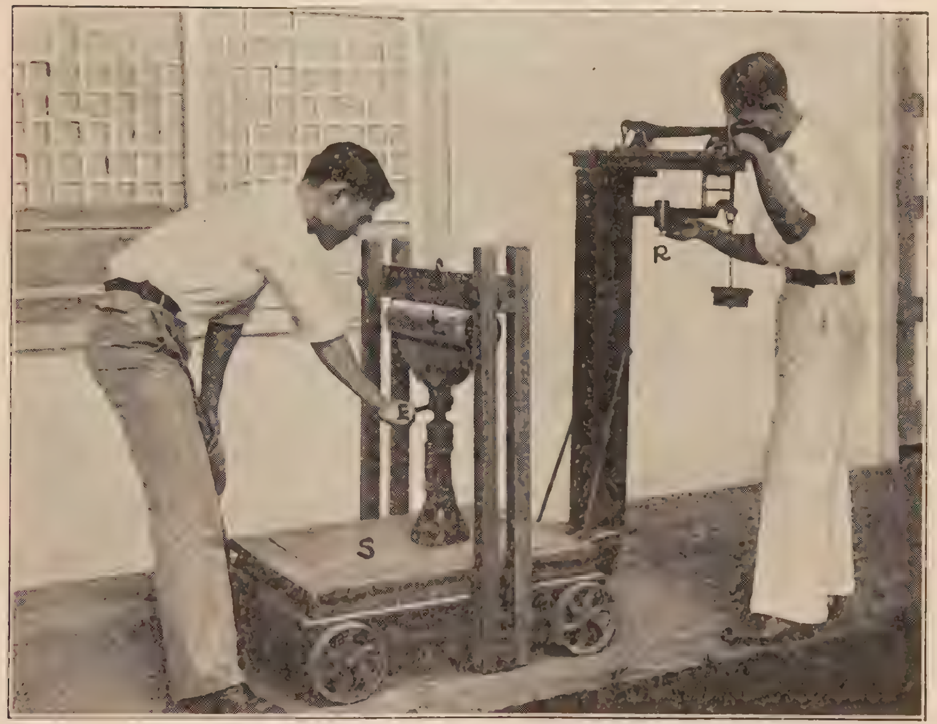

Fig. 8.—Jack screw machine. Note the tubes in position for crushing. *j*, jack screw; *t*, tube; *k* and *f*, pieces of board serving as press; *s*, platform of scale balance; *E*, force applied; *R*, recorded force by the balance.

The maximum depth of the drain system in this work was 3.3 feet; the greatest width of trench at the top of the pipe was 0.27 foot (3.25 in.). Therefore, $C = 3.63$ (from table XV, Parsons (1915). Durano (1927) reported that the poorly drained field used in this study is underlaid with heavy clay soil. From Parsons (1915) table XVI, top soil and yellow clay, loose, wet, $w = 80$ lbs. per cubic foot; yellow clay, saturated, $w = 145$ lbs. per cubic foot. For computation, 145 lbs. per cubic foot shall be considered.

Substituting values:

$W = 3.63 \times 145 \times (0.27)^2 = 38$ lbs. per linear foot.

Taking the shortest width of trench which was 0.17 foot (2 inches), $C = 3.79$, then:

$W = 3.79 \times 145 \times (0.17)^2 = 15.8$ lbs. per linear foot.

Taking the minimum breaking force of the tubes and the computed maximum earth pressure, the factor of safety of that tube is 301 ÷ 38 or 7.9. This factor of safety is 5 times greater than the factor of safety for drain tiles given by Parsons.

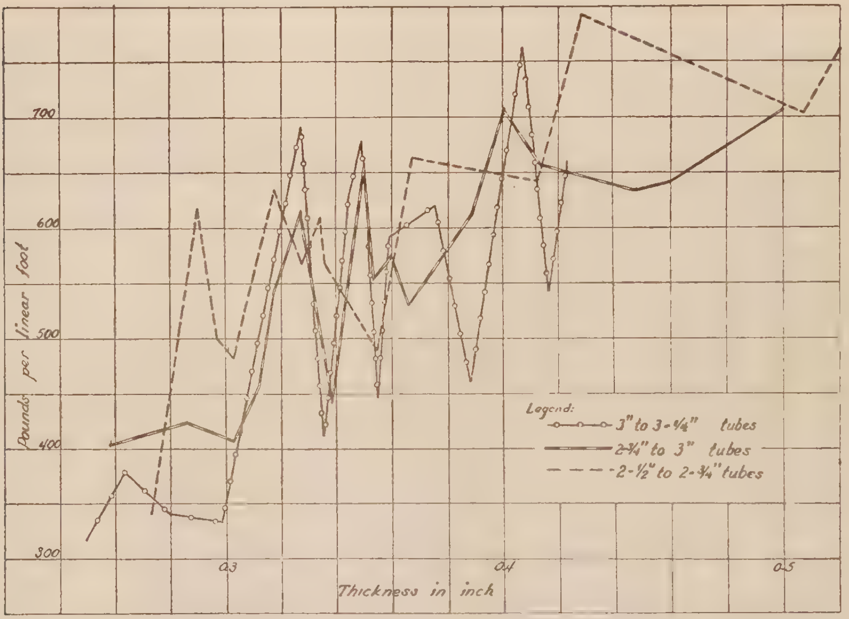

Chart 1.—Showing the relation between the thickness of the wall and the breaking strength of the tubes; also between the diameters and the breaking strength.

Tables 1 and 2 show that the breaking strength of the bamboo tubes from 2 to 3½ inches in diameter ranged from 300 to 1000 pounds per linear foot with 400 to 500 pounds per linear foot as the average occurrence. The thickness of the wall varied from 0.117 to 0.537 inch. The breaking strength of the tubes was so variable that it is hard to find a relationship between the diameter and the breaking strength, as may be seen in chart 1. Also, it is hard to find a relationship between the thickness of the wall and the breaking force. On the whole, however, it will be seen from the tables that, for the same diameters, the thicker the walls the greater the breaking strength. This is also shown in chart 1. The great variability of the breaking strength may be attributed to some factors. Two factors are: (1) The machine is not yet perfected; although at the present it is the best apparatus the Engineering Department laboratory can afford. (2) The tubes were not the same age.

The strength found in the tests compares favorably with the breaking strength of common clay tiles. Table 3 shows a good comparison between the breaking strength of bamboo "tile" and of clay tile. Note that for the same size of tile, the bamboo tube has a greater breaking strength than the clay tile.

Condition of the tubes in the soil as affected by the preservatives

After twenty months in the soil, twenty-four tubes of each treatment were dug out and tested for breaking strength. The tests indicate that the tar-treated tubes were in better condition than any of the three groups. Except for three tubes, the breaking strength of the tarred tubes ranged from 142 to 441 pounds per linear foot. The other three groups were in poorer condition. In all cases the untarred tubes were water-worn inside. (See fig. 9). Two tubes in the 1:2 salt-treated group were so worn out inside that they easily yielded to the crushing force of the fingers. In a majority of cases, the breaking strength of the tubes of the three groups was between 100 and 200 pounds per linear foot.

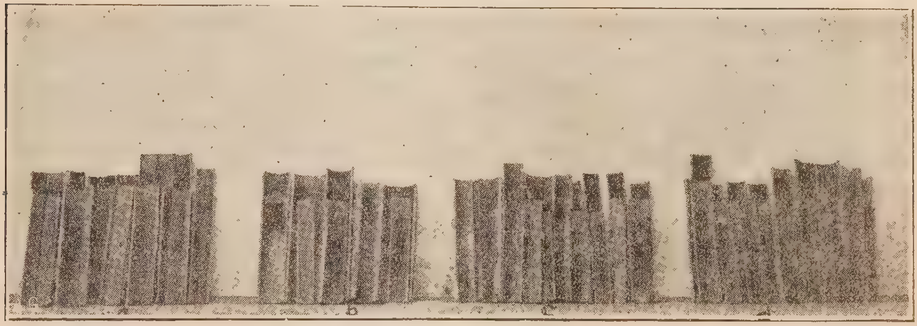

Fig. 9.—After crushing the tubes, 20 months old in the soil. *a*, tar-treated; *b*, 1:2 salt treated; *c*, 1:4 salt treated; *d*, control. Note the roughness of the inside surface of *b*, *c*, and *d*. They show the water-worn condition.

The salt treatment seemed to have no effect at all on the preservation of the tubes. Both salt-treated and untreated tubes showed the same condition; their inner surface was water-worn. The breaking strength of the tubes of the three groups, though variable, did not widely differ from each other. (See tables 5, 6, and 7). As shown by the tests the breaking strength of the tubes of the untarred group for the same size is, on the whole, very much lower than that of the tarred tubes.

The tubes withstood the field conditions for twenty months without breaking. As to how long they will endure in the soil remains yet to be seen. Present results seem to show that the tar-treated tubes will last longer than the untreated ones. The use of coal tar as a preservative for materials is recognized.

The time was not sufficient to justify any generalization as to what would happen to the drain lines after the tubes had rotted. Elliot (1919), however, states that after the soil has sufficiently set and hardened, the tiles are not disturbed by practically any field operations. A time may be reached that the hole formed will remain, even without the tile unless the soil is disturbed.

Effectiveness as a drain

The data on the rate of precipitation in the Experiment Station was furnished by the Plant Physiology Department. There is always a close relationship between rainfall and run-off and hence discharge of the drains.

At the writing of this paper (Jan., 1930), the drain system still works effectively. After the heavy rains on November 12, 1929, the middle part in each of the three lateral branches was opened to see whether water was flowing. Each branch revealed a steady flow of water. This shows that the branches were still in good condition. Whenever the 24-hour period rainfall was 1.57 inches (40 mm.) or more, discharge from the drains was observed.

SUMMARY AND CONCLUSIONS

Summary of the results and discussions may be given as follows:

1. The tubes tested were sufficiently strong to resist crushing forces of the soil. The minimum breaking strength of all the tubes tested was 301 pounds per linear foot. The tube was 3.156 inches in diameter and the thickness of the wall was 0.263 inch. The tube having this minimum breaking strength according to Parsons' factor of safety must carry 201 pounds per linear foot. This strength is much greater than the maximum computed earth pressure.

2. Tubes coated with coal tar were found to be stronger than any of the other treated tubes.

3. After twenty months in the soil, the salt-treated and untreated tubes were water-worn inside. The tar-treated tubes were not.

4. At the time of the writing of this paper (Jan., 1930), the drain system still works effectively. Discharge from the main was observed whenever the 24-hour period rainfall was 1.57 inches (40 mm.).

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TABLE 1

Showing the breaking strength of the tubes in pounds per linear foot. Tested by the lever machine

	DIAMETER	THICKNESS	LENGTH	BREAKING STRENGTH		DIAMETER	THICKNESS	LENGTH	BREAKING STRENGTH
	in.	*in.*	*ft.*	*lbs. per linear ft.*		*in.*	*in.*	*ft.*	*lbs. per linear ft.*
1	3.437	0.343	17.125	462.48	50	2.862	0.459	13.25	639.37
2	3.375	0.281	15.375	449.25	51	2.843	0.4	11.125	794.15
3	3.343	0.328	16.0	822.68	52	2.843	0.337	17.0	449.88
4	3.312	0.375	17.0	575.21	53	2.843	0.328	13.875	626.17
5	3.312	0.343	13.875	562.05	54	2.843	0.287	14.125	362.40
6	3.312	0.343	16.375	596.19	55	2.831	0.312	13.75	506.87
7	3.281	0.422	17.125	612.32	56	2.831	0.287	14.75	494.71
8	3.281	0.343	16.375	550.40	57	2.812	0.368	14.5	498.68
9	3.281	0.328	13.75	731.90	58	2.812	0.259	13.25	405.26
10	3.281	0.263	12.125	389.30	59	2.8	0.5	12.25	708.81
11	3.250	0.422	17.125	459.09	60	2.781	0.353	15.625	552.83
12	3.250	0.390	15.625	432.06	61	2.781	0.312	14.5	416.21
13	3.250	0.337	13.250	466.23	62	2.768	0.359	16.375	473.99
					63	2.75	0.431	15.5	1010.01
14	3.218	0.406	14.625	764.65	64	2.75	0.40	13.875	625.42
15	3.175	0.359	14.0	640.19					
16	3.156	0.384	16.75	501.99	65	2.737	0.318	14.75	765.39
17	3.156	0.353	15.75	491.45	66	2.718	0.328	14.25	521.33
18	3.156	0.343	15.5	643.81	67	2.687	0.525	13.5	824.26
19	3.156	0.297	16.5	329.60	68	2.687	0.368	14.25	716.59
20	3.156	0.263	16.375	301.16	69	2.675	0.303	15.625	454.81
21	3.156	0.25	16.5	320.16	70	2.656	0.29	15.25	602.61
22	3.125	0.415	16.375	540.25	71	2.643	0.412	15.5	641.43
23	3.125	0.281	14.0	328.11	72	2.625	0.509	12.0	751.51
24	3.112	0.375	16.125	621.48	73	2.625	0.297	15.0	501.42
25	3.112	0.350	14.0	693.18	74	2.612	0.318	15.0	509.16
26	3.093	0.359	16.125	547.15	75	2.612	0.303	14.875	507.05
27	3.093	0.281	15.0	364.67	76	2.612	0.272	15.312	341.03
28	3.081	0.334	16.125	412.41	77	2.606	0.353	14.0	458.60
29	3.062	0.353	16.0	407.55	78	2.581	0.334	15.25	624.59
30	3.031	0.422	15.875	661.03	79	2.581	0.328	15.125	511.94
31	3.031	0.312	13.5	481.06	80	2.562	0.337	13.875	567.57
32	3.031	0.263	11.5	467.16	81	2.55	0.428	11.75	844.57
33	3.031	0.250	13.75	446.40	82	2.531	0.368	16.375	625.37
34	3.0	0.343	13.75	618.43					
35	3.0	0.328	13.125	691.52	83	2.487	0.537	14.0	679.80
36	3.0	0.322	15.125	607.59	84	2.456	0.203	14.875	359.29
					85	2.437	0.259	11.5	395.31
37	2.987	0.45	14.0	632.84	86	2.375	0.24	12.0	324.28
38	2.987	0.343	14.375	539.01	87	2.362	0.459	12.875	816.91
39	2.987	0.343	13.875	510.30	88	2.343	0.259	12.5	357.77
40	2.987	0.303	14.0	407.69	89	2.343	0.203	15.0	247.98
41	2.968	0.368	13.5	550.48	90	2.331	0.225	11.5	350.31
42	2.956	0.412	16.625	494.65	91	2.268	0.234	11.25	424.45
43	2.956	0.39	15.125	619.98	92	2.25	0.218	10.5	329.12
44	2.937	0.412	12.875	826.96					
45	2.937	0.328	15.375	609.21	93	2.218	0.218	11.0	319.92
46	2.893	0.35	15.0	661.93	94	2.143	0.209	11.125	334.83
47	2.893	0.318	13.0	542.82	95	2.125	0.234	12.5	332.85
48	2.893	0.312	15.5	451.69	96	2.125	0.218	11.375	362.75
49	2.875	0.359	15.25	683.63	97	2.062	0.228	10.875	462.45

TABLE 2

Showing the breaking strength of the tubes in pounds per linear foot. Tested by jack screw machine

INSIDE DIAMETER	THICKNESS	LENGTH	BREAKING STRENGTH
in.	*in.*	*ft.*	*lbs. per linear ft.*
3.375	0.381	15.375	736.96
3.362	0.428	14.875	976.13
3.331	0.334	16.0	645.48
3.331	0.250	15.75	553.14
3.312	0.390	17.0	604.09
3.281	0.334	16.125	821.71
3.237	0.453	17.25	885.20
3.206	0.328	14.375	459.45
3.187	0.462	14.0	884.21
3.156	0.334	15.5	502.45
3.063	0.353	17.0	431.06
3.050	0.365	16.125	385.07
3.044	0.337	15.375	466.01
2.968	0.40	16.0	544.83
2.956	0.468	15.25	754.08
2.956	0.428	16.0	815.10
2.956	0.334	16.125	394.89
2.956	0.318	14.125	500.52
2.956	0.312	14.125	384.83
2.937	0.306	15.875	335.59
2.937	0.29	15.125	420.65
2.925	0.381	14.5	638.33
2.925	0.343	14.875	436.42
2.925	0.289	14.25	453.89
2.906	0.431	15.75	680.53
2.906	0.415	13.75	711.55
2.906	0.337	15.375	509.28
2.906	0.322	15.25	500.01
2.906	0.29	14.625	406.69
2.893	0.318	13.125	471.47
2.893	0.303	17.876	369.52
2.875	0.384	15.375	498.29
2.875	0.359	13.75	592.51
2.875	0.359	13.375	592.14
2.875	0.359	12.25	693.85
2.875	0.343	13.312	551.52
2.875	0.343	14.875	532.43
2.875	0.322	12.75	513.71
2.875	0.29	14.125	498.09
2.862	0.328	15.625	513.30
2.862	0.437	13.125	796.92
2.862	0.343	14.375	602.56
2.843	0.5	14.0	1021.30
2.843	0.312	13.625	515.21
2.831	0.5	14.125	1099.17
2.831	0.468	13.5	782.02
2.812	0.39	15.125	873.07
2.812	0.281	14.25	455.56
2.812	0.275	11.5	530.06
2.8	0.365	14.312	522.02
2.8	0.343	14.5	509.61
2.781	0.384	15.875	641.31
2.768	0.263	14.0	441.82
2.75	0.312	13.75	463.10
2.737	0.328	14.125	429.76
2.718	0.275	13.25	545.93
2.687	0.509	11.437	1132.91
2.687	0.406	12.75	686.40
2.687	0.259	14.0	343.57
2.668	0.331	14.25	550.23
2.668	0.259	13.375	393.45
2.656	0.353	13.75	648.38
2.656	0.322	15.25	456.15
2.656	0.243	13.5	414.96
2.643	0.422	13.75	885.88
2.643	0.318	15.25	537.34
2.643	0.272	13.25	391.70
2.643	0.256	12.25	391.71
2.625	0.263	14.375	516.24
2.612	0.359	17.5	501.44
2.612	0.312	15.5	573.30
2.612	0.263	11.625	453.96
2.581	0.375	13.0	776.56
2.581	0.25	12.625	454.59
2.5	0.218	12.0	386.98
2.437	0.172	16.25	347.69
2.425	0.225	11.625	354.72
2.375	0.228	11.0	540.48
2.343	0.263	12.675	560.62
2.331	0.397	12.75	1111.69
2.268	0.234	10.875	483.08
2.237	0.24	11.625	466.45
2.175	0.24	11.0	479.76
2.156	0.228	11.5	370.74
2.147	0.24	17.125	393.57
2.125	0.25	11.25	564.13
2.112	0.234	12.125	529.08

TABLE 3

Showing a comparison between the breaking strength of clay tile and bamboo "tile"

CLAY TILE[a]			BAMBOO "TILE"		
Diameter	Thickness of wall	Breaking strength	Diameter	Thickness of wall	Breaking strength
in.	*in.*	*lbs. per lin. ft.*	*in.*	*in.*	*lbs. per lin. ft.*
12	1	1287			
12	1	1168			
12	1	938			
15	1	1032			
15	1	1193			
6	0.625	990			
6	0.625	1060			
6	0.625	815			
3	0.375	276	3.093[b]	0.359	547.17
3	0.375	170	3.093	0.281	364.67
3	0.375	162	3.081	0.334	412.41
3	0.375	173	3.062	0.353	407.55
3	0.375	161	3.031	0.312	481.06
3	0.375	195	3.031	0.263	467.16
3	0.375	154	3.031	0.250	446.40
3	0.375	279	3.0	0.343	618.43
3	0.375	186	3.0	0.328	691.52
3	0.375	121	3.0	0.322	607.59
			3.063[c]	0.353	431.06
			3.050	0.365	385.07
			3.044	0.337	466.01

[a] Figures taken from Record No. 5 and Record No. 6, pages 137 and 138 of Elliot (1919).

[b] Figures taken from table 1.

[c] Figures taken from table 2.

TABLE 4

Showing the breaking strength of the tar-treated tubes, twenty months old in the soil[a]

	INSIDE DIAMETER	THICKNESS	BREAKING STRENGTH	REMARKS
	in.	*in.*	*lbs. per lin. ft.*	
1	3.047	0.343	416.98	
2	3.016	0.297	220.00	
3	2.984	0.343	441.44	
4	2.890	0.375	422.39	
5	2.890	0.312	357.41	
6	2.859	0.334		Less than 200 pounds
7	2.859	0.234	302.01	
8	2.797	0.303	219.32	
9	2.797	0.263	193.88	
10	2.765	0.365	242.00	
11	2.718	0.272		Less than 200 pounds
12	2.687	0.303	270.09	
13	2.640	0.312	292.28	
14	2.593	0.259		Less than 200 pounds
15	2.578	0.397	412.50	
16	2.531	0.353	417.87	
17	2.263	0.390	327.91	
18	2.263	0.363	248.47	
19	2.263	0.234	195.2	
20	2.263	0.218	213.52	
21	2.172	0.25	228.37	
22	2.156	0.228	142.73	
23	2.093	0.234	399.69	
24	2.078	0.240	218.40	

[a] Tubes tested by the lever machine.

TABLE 5

Showing the breaking strength of 1:2 salt-treated tubes, twenty months old in the soil[a]

INSIDE DIAMETER	THICKNESS	BREAKING STRENGTH	REMARKS
in.	*in.*	*lbs. per lin. ft.*	
3.218	0.39	194.22	Inner surface of tube was slightly water-worn
3.0	0.25	127.36	Inner surface water-worn.
2.937	0.281	143.70	Water-worn.
2.875	0.336	277.89	Very slight water-worn.
2.859	0.289	254.57	Slight water-worn.
2.812	0.281	114.78	Water-worn.
2.781	0.258	171.38	Water-worn.
2.765	0.274	80.45	Greatly water-worn.
2¾–3			Tube crushed by fingers.
2.703	0.242	122.10	Water-worn.
2.672	0.218	141.06	Water-worn.
2.656	0.234	168.09	Water-worn.
2.625	0.258	124.33	Water-worn.
2.578	0.25	79.20	Water-worn.
2½–2¾			Tube crushed by fingers.
2.437	0.203	123.53	Water-worn.
2.422	0.203		Less than 40 pounds.
2.343	0.242	150.18	Water-worn.
2.312	0.234	107.63	Water-worn.
2.297	0.264	184.8	Water-worn.
2.218	0.25	268.06	Water-worn.
2.187	0.187	243.52	Very slightly water-worn.
2.078	0.218	167.70	Water-worn.
2–2¼			Tube crushed by fingers.

[a] Tubes tested by the lever machine.

TABLE 6

Showing the breaking strength of 1:4 salt-treated tubes, twenty months old in the soil[a]

	INSIDE DIAMETER	THICKNESS	BREAKING STRENGTH	REMARKS
	in.	*in.*	*lbs. per lin. ft.*	
1	3.078	0.305	211.20	Inner surface of tube was water-worn.
2	3.031	0.39	103.84	Water-worn.
3	3.031	0.383	77.64	Greatly water-worn.
4	3.0	0.187		Less than 40 pounds.
5	2.984	0.305	285.89	Water-worn.
6	2.981	0.212	62.40	Greatly water-worn.
7	2.937	0.305	193.60	Water-worn.
8	2.922	0.242	135.30	Water-worn.
9	2.875	0.195	42.24	Greatly water-worn.
10	2.859	0.25	165.68	Water-worn.
11	2.687	0.234	59.40	Greatly water-worn.
12	2.687	0.187		Less than 40 pounds.
13	2.672	0.263	105.60	Water-worn.
14	2.640	0.258	196.37	Water-worn.
15	2.609	0.32	147.40	Water-worn.
16	2.593	0.218	151.80	Water-worn.
17	2.5	0.25	133.76	Water-worn.
18	2.468	0.274	97.15	Greatly water-worn.
19	2.468	0.234	241.52	Water-worn.
20	2.375	0.263	84.08	Greatly water-worn.
21	2.312	0.218	149.84	Water-worn.
22	2.218	0.18	120.00	Greatly water-worn.
23	2.187	0.14	98.17	Greatly water-worn.
24	2.109	0.242	214.97	Water-worn.

[a] Tubes tested by the lever machine.

TABLE 7

Showing the breaking strength of the non-treated tubes, twenty months old in the soil[a]

INSIDE DIAMETER	THICKNESS	BREAKING STRENGTH	REMARKS
in.	*in.*	*lbs. per lin. ft.*	
3.172	0.367	265.76	Inner surface was water-worn.
3.156	0.297	134.40	Water-worn.
3.047	0.305	63.36	Greatly water-worn.
2.937	0.281	107.15	Water-worn.
2.918	0.252	54.30	Greatly water-worn.
2.859	0.234	209.08	Water-worn.
2.843	0.32	242.20	Water-worn.
2.843	0.289	306.64	Slight water-worn.
2.812	0.227	186.01	Water-worn.
2.75	0.343	81.75	Greatly water-worn.
2.687	0.320	260.59	Water-worn.
2.64	0.203	66.00	Greatly water-worn.
2.609	0.414	148.13	Water-worn.
2.515	0.289	160.10	Water-worn.
2.5	0.367	167.20	Water-worn.
2½–2¾			Tube crushed by fingers.
2.375	0.218	50.76	Greatly water-worn.
2.281	0.263	288.00	Water-worn.
2.25	0.218	45.25	Greatly water-worn.
2.25	0.187	107.71	Water-worn.
2.218	0.25	228.80	Water-worn.
2.203	0.242	144.39	Water-worn.
2.187	0.281	184.80	Water-worn.
2.187	0.218	220.88	Water-worn.

[a] Tubes tested by the lever machine.

TABLE 9

Showing the daily rainfall at the College Experiment Station

DATE	1928			1929						
	OCT.	NOV.	DEC.	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
1	12.6	4.4	0	0	0	20.2	0	0	0	2.6
2	2.8	0	0	0	0	0	0	0	0	0
3	1.0	0	2.8	14	5.0	27.0	124.0[e]	42.0[e]	1.5	2.0
4	6.8	10.0	0	0	0	40.9[e]	43.5	43.0[e]	3.0	6.0
5	0	7.9	0	0	12.0	6.0	0	40.0[e]	2.3	5.0
6	0	2.3	0	0	9.5	1.5	0	3.5[e]	13.5	15.9
7	0	22.3	0	2.3	49.0[e]	0	0	14.5	6.2	1.2
8	2.3	0	8.6	0	24.3	47.7[e]	0	52.5[e]	2.7	0
9	2.8	0	7.7	4.0	9.5	32.6	0	24.0[e]	2.3	1.5
10	7.7	2.7	7.2	0	14.8	5.0	0	8.0	1.8	1.8
11	0	3.1	9.9	0	0	0	0	29.0	71.0[e]	0
12	0	5.0	0	0	46.3[e]	0	0	8.5	42.0	0
13	0	2.0	5.9	0	4.0	0	14.0	41.3[e]	0	0
14	0	0	4.5	0	22.0	0	0	0	9.2	0
15	4.7	0	3.7	0	53.5[e]	0	5.5	5.5	4.4	0
16	0	9.0	0	0	24.0	0	0	0	0.5	0
17	0	0	0	0	0	0	48.5[e]	6.5	5.6	0
18	0	0	2.5	0	12.5	0	102.5	2.2	5.9	3.8
19	0	0	1.8	2.2	0	44.5[e]	8.5	18.8	17.3	3.9
20	0	0	0	0	9.8	0	0	0.5	7.6	1.0
21	10.3	0	0	28.0	54.5[e]	0	0	0	21.8	0
22	6.3	0	3.7	0	24.8	0	0	0	13.5	0
23	14.9	17.9	3.9	0	0	2.8	0	0	0.5	2.3
24	7.2	84.4[e]	0	0	0	11.4	1.0	0.3	0	0
25	11.8	6.8	1.2	0	0	0	0	0	0	0
26	17.8	0	0	0	19.5	0	0	3.8	0	47.1[e]
27	0	1.6	0	0	0	0	0	0.8	1.0	10.6
28	0	5.7	0	65.5[e]	0	10.5	0	10.6	0	2.8
29	0	0	1.5	0	0	0	1.2	0	0	6.4
30	5.8	0	5.3	36.0	0	0	2.5	0	13.5	0.5
31	0		0		0	10.0		0.5		2.6

[e] Discharge observed but not measured.

PUBLISHED CONTRIBUTIONS OF THE COLLEGE OF AGRICULTURE: VIII[1]

B. M. GONZALEZ
Dean, College of Agriculture

It is a source of satisfaction and pride to be able to present in the last number of THE PHILIPPINE AGRICULTURIST at the end of each academic year an inventory, as it were, of the intellectual output of the College during the year. In the same manner as accounts are balanced and a report is made of the progress of the institution to its financial administrators at the end of each year, this list is presented to the public and the scientific world as the annual tribute of the College to world progress. The College staff is alive to its responsibilities, to its local and world constituency in being the agency in this corner of the globe for the study of agricultural problems and the sciences fundamental to agriculture.

II. EXPERIMENT STATION CONTRIBUTIONS

The contributions are numbered serially as reported. For Nos. 1-199, *see* THE PHILIPPINE AGRICULTURIST XII, No. 7, 1923. For Nos. 200-287, *see* THE PHILIPPINE AGRICULTURIST XIII, No. 10, March, 1925. For Nos. 288-354, *see* THE PHILIPPINE AGRICULTURIST XIV, No. 10, March, 1926. For Nos. 355-440, *see* THE PHILIPPINE AGRICULTURIST XV, No. 10, March, 1927. For Nos. 441-517, *see* THE PHILIPPINE AGRICULTURIST XVI, No. 10, March, 1928. For Nos. 518-595, *see* THE PHILIPPINE AGRICULTURIST XVII, No. 10, March, 1929. For Nos. 596-643, *see* THE PHILIPPINE AGRICULTURIST XIX, No. 2, July, 1930.

(644) VILLEGAS, VALENTE. 1930. Observations on the breeding activities of carabaos. The Philippine Agriculturist **19**: 3–9.

(645) BALTAZAR, EULALIO, P. 1930. Twine and sack making as a possible home industry in the Philippine Islands. The Philippine Agriculturist **19**: 11–26. *Fig. 1–8.*

(646) LEONCIO, JACINTO, B. 1930. The relation to abaca, or Manila hemp, of the banana wilt fungus *Fusarium cubense* EFS. The Philippine Agriculturist **19**: 27–42. *Fig. 1–2.*

(647) GINES, FELIX G. 1930. Relative effects of different iron salts upon growth and development of young rice plants. The Philippine Agriculturist **19**: 43–52.

(648) ROMERO, TARSILO. 1930. Multiplication of selected coffee trees in the College of Agriculture by grafting. The Philippine Agriculturist **19**: 53–67. *Fig. 1–5; chart 1.*

(649) EALA, QUINTIN A. 1930. An investigation on the emigration of Ilocanos under contract to the Hawaiian Sugar Planters' Association from the provinces of Ilocos Sur and Ilocos Norte: the economic and social causes. *Abstract* in The Philippine Agriculturist **19**: 69.

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EXCHANGE NOTES

In the opinion of local hemp dealers and exporters, the Philippines is expected to retain the monopoly of the Manila hemp at least for a period of ten more years, at the present rate of development of the abacá industry in Sumatra, unless the local industry is entirely neglected. In volume of output and in tensile strength and quality, Manila hemp will never be surpassed by the Sumatra product or by fiber produced in any other country, it is pointed out. Demonstrations have shown that the Sumatra fiber is inferior to the Philippine fiber. It is said that soil and climatic conditions in other countries, like Java, are not suitable to the growing of abacá.

—*Commerce and Industry Journal* (Philippines).

Plant diseases cost the United States $1,500,000,000 annually, according to Dr. R. J. Haskell, plant pathologist, United States Department of Agriculture. The wheat crop alone is reduced 97,000,000 bushels a year by rusts, smuts, root rots and other diseases.

—*The Prairie Farmer.*

"The United States is entirely free from such serious diseases of animals as rinderpest, contagious pleuropneumonia, surra and foot-and-mouth disease," according to a statement made by Dr. John R. Mohler, chief of the U. S. Bureau of Animal Industry, to the Inter-American Conference on Agriculture, Forestry and Animal Industry that met recently in Washington. Foot-and-mouth disease has been introduced occasionally but prompt slaughter of affected animals and disinfection of premises has quickly eradicated it.

—*Science.*

Don't worry about your competitors. They are the spice of life. They are the zest of business.

If it weren't for your competitors there would be moss and ivy all over you and your business.

You are losing more money by neglect than you are by competition. You are losing more by waste—by lack of team play—by jogging along in a rut.

If your competitors are ahead of you, be a good loser. Don't squeal and make excuses. Then play the game harder. Get at it with all the brains you have and all you can hire.

Don't settle down to be a tail-ender with a grouch. Make up your mind to win. Show your competitors that you're still in the running.

—*The Rice Journal.*

Very few people realize the food value of rice. It is more generally used here than in the north, where it is only used in soups and puddings. In the East they long ago learned that with rice, and almost rice alone, life could be well sustained and a goodly amount of energy expended, but not on white polished rice.

Rice has more than eighty-six per cent of pure value,—more than wheat, oats, rye, or even meat, when taken bulk for bulk. It is wonderfully rich in the highest quality of health giving values. It is, moreover, of exceptionally good quality for food in that it does not ferment readily when properly washed and cleaned.

For this reason it is most beneficial for neurosthenics and all that class of people who suffer from an over-acid condition of both stomach and blood. These poor people are continually pouring in stuff that becomes acid and burns up their tissues, fermenting and causing fevered conditions that continually call for more acids, thereby keeping the furnace going at full blast.

The Chinese, the Japanese, and those races that use rice extensively, live in a climate and under conditions that would put an ordinary white person out of commission in about two weeks; but these yellow races live, work hard and flourish. They seldom have rheumatism or other acid conditions of the blood, and it is due to their diet of rice. They got food values, but do not get bad results, as they would from fermentable stuff.

If other races would eat more rice, however, and less meat and white bread, the results would soon be apparent in fewer cases of kidney and bladder diseases, dropsy and rheumatism. There is almost no limit to the number of ailments than can be directly traced to an irritable and acid stomach.

But it must not be the white rice which has had its virtues polished off it; but the rich brown rice, which so many people think is not the best because it is not white, when as a matter of fact, as a food, and that is what it is bought for, it is worth more than double.

—*The Journal of the Jamaica Agricultural Society.*

According to a Times correspondent in New York, a number of well-known industrialists, bankers, and financiers, including former Governor Lowden, of Illinois, Mr. Bernard M. Baruch, of New York, and Mr. Herbert F. Perkins, president of the International Harvester Company, have organized a concern which has been named the Internationl Cornstalks Processes, Incorporated, with a capital of $1,000,000 for the manufacture of the thin lumber substitutes and other synthetic products from corn (maize) stalks. The company has already taken over the properties of the Maize Wood Products Corporation at Dubuque, Iowa, and is planning to build a chain of corn stalks mills in the corn belt which are expected to pay farmers $3 a ton for stalks. It is claimed for maize wood, the synthetic product, that it has lighter weight, more tensile strength and less tendency to warp than thin natural wood and costs less to produce.

—*Tropical Life.*

The largest sow ever exhibited at the National Swine Show was the property of John Anderson & Sons, Illinois. This Poland China sow weighed 1,080 pounds. The heaviest boar exhibited at the same show was a Poland China belonging to Harry Adams, Illinois. This boar weighed 1,130 pounds in show condition.

—*Farmer and Stockman* (Missouri).

COLLEGE AND ALUMNI NOTES

On the evening of December 17, 1930, Doctor Stevens, Baker Memorial Professor, gave his second lecture on the "Effect of ultra-violet irradiation on fungi". This most interesting lecture was the sixth of the series of semi-popular lectures which Doctor Stevens graciously gave during his year in the College.

Dr. Robert Preston Brooks, head of department of economics in University of Georgia, was a recent Campus visitor. Doctor Brooks is traveling leisurely during a year's leave. He plans to reach New York next August. He was in the Philippines two weeks. Doctor Brooks is writing a series of articles giving his observations on economic conditions of the countries in which he travels.

Dr. R. C. Miller, professor of zoölogy, University of Washington, visited the College recently. Doctor Miller conferred with Doctor Villadolid regarding his biological work in Laguna de Bay, particularly on that relating to the tulla, *Corbucula manillensis* Philippi, a common food clam. Doctor Miller is spending his sabbatical leave as professor of biology in Lingnan University (formerly Canton Christian College), Canton, China.

On January 9, Dr. Stanton Youngberg, Director of Bureau of Animal Industry, was a Campus visitor.

The Baker Memorial Scholarship for 1930-'31 was awarded by the committee on this award to Engracio Basio. According to the conditions of this scholarship it is awarded to a self-supporting student of the senior class. The recipient is selected "on the basis of character, promise of future usefulness, and scholarship".

Engracio Basio entered the College in June 1925 with some credits from Cebu High School, in September of that year he was appointed student assistant in the library. He has held this position ever since, receiving promotions in recognition of his faithfulness and efficiency. Basio has attended four summer sessions. His scholastic record up to and including the first semester of the College year 1930-'31 is an average of 2.42. This year Basio is Governor of the Rancher's Club, an organization of students majoring in Animal Husbandry. Basio's name has never appeared in any delinquency list of any form and as to character and deportment his record is absolutely clean. Engracio Basio is to be congratulated on being the second recipient of the Baker Memorial Scholarship, not so much for its monetary value as that he meets the condition of the award.

The Los Baños Biological Club held a meeting January 15, 1931, at 7:30 p. m., in the Lecture Hall of the Department of Agricultural Chemistry.

The following papers were read and discussed:

1. The amount and fertilizing constituents of fresh solid excreta voided by Philippine horses. By Dr. V. Villegas, Miss M. Manahan, and Dr. F. T. Adriano.
(Read by Miss Manahan.)
2. A method of calculating the number of trees for measurement in the Bureau of Forestry Rubber Plantation. By Prof. A. P. Racelis.

The Los Baños Biological Club was host to the Philippine Society of Parasitology at a luncheon at the College of Agriculture on January 24. After luncheon the members of the two societies adjourned to the Lecture Hall of the Department of Agricultural Chemistry where a joint meeting was held. Many members of the faculty and students of the Los Baños Colleges attended this meeting. A paper entitled "Physiology of reproduction in the ox: Changes in the generative organs in open and pregnant heifers and cows" from the Los Baños Biological Club was read by Dr. Miguel Manresa, of the Department of Animal Husbandry. Dr. Cristobal Manalang, Chief of the Division of Malaria Control of the Philippines Health Service in Manila, read the paper from the Philippine Society of Parasitology. Doctor Manalang's paper entitled "Notes on malaria cases and deaths" was most interesting, especially as most of the earlier students at Agricultural College, some of whom are now on the faculty of the College of Agriculture and the School of Forestry, know what malaria is through personal experience. Many new and interesting things about incidence of malaria, cure of the disease, specificity of quinine as cure, occurrence of malaria in mixed infection with some other diseases, the importance of the microscope in accurate diagnosis of the disease were dwelt upon by Doctor Manalang.

In the evening of December 23, there was the usual Christmas party for the students remaining on the Campus during Christmas holidays. There were games, songs, refreshments and every one had good time.

On Christmas under the leadership of Miss Cole, Miss Fraser and Miss Reed, a group of students sang the well-loved Christmas carols. After singing at the band stand in the Athletic Field their route was Copeland Road, Forest Road, and Hill Road. This gave all Dormitory students and Faculty Hill residents the joy and pleasure which these carols always bring to the Christmas season.

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